Integrated Environmental Solutions

222 South Riverside Plaza
Suite 820
Chicago, IL 60606
Telephone: 312-575-0200
Fax: 312-575-0300

EVALUATION OF REMEDIATION OF GROUNDWATER BY NATURAL ATTENUATION

L. E. CARPENTER AND COMPANY
WHARTON, NEW JERSEY
SRP NO. NJD002168748

Prepared By
RMT, Inc.

May 2000

Galen J. Kenoyer, Ph.D.
Consulting Hydrogeologist

Nicholas Clevett
Project Manager

Table of Contents

List of Tables

List of Figures

List of Appendices

Section 1
Introduction

1.1 Background

The L.E. Carpenter facility is located at 170 North Main St., Borough of Wharton, Morris County, New Jersey (see Figure 1). The site history has been summarized in the 1992 Final Supplemental Remedial Investigation Addendum Report (Weston, 1992a), and is summarized briefly here. The site was operated as a manufacturing facility for vinyl wall coverings from 1943 to 1987. Subsequently, it has been used as a warehouse and manufacturing facility. Key compounds used in the manufacturing process or plant operations included a plastisol compound, coal, #6 fuel oil, xylenes, and methyl ethyl ketone. Some waste materials were disposed into an unlined, on-site surface impoundment. In addition, the site had an operating iron mine and forge in the late 1800's to early 1900's. In 1982, an Administrative Consent Order (ACO) was entered into with the NJDEP, followed by a 1983 Addendum, and a 1986 additional ACO.

A map of current conditions at the site is presented as Figure 2. Site remediation activities began in 1982, and have included, but are not limited to, removal of 4,000 cubic yards of waste from the surface impoundment, removal of underground and aboveground storage tanks, floating product recovery, and building demolition and removal. From 1984 to 1992, more than 5,000 gallons of floating free product were removed by a series of recovery wells (Weston, 1992a). Free product recovery continued, and since 1997, enhanced fluid recovery (EFR) wells have been used to recover an additional 2,000 gallons of free product. Currently, the remaining free product covers an area of approximately 100 feet by 600 feet on-site, with typical apparent product thickness values in wells of less than a foot, but ranging up to several feet in a few wells.

Groundwater in the vicinity of the free product zone contains three main constituents of concern that exceed New Jersey groundwater quality standards (NJGQS): ethylbenzene, xylenes, and diethylhexyl phthalate (DEHP), also known as bis-2-ethylhexyl phthalate (NJDEP, 1994). Typically, concentrations of constituents of concern in the groundwater decrease substantially over relatively short distances from the free product area, such that, within 100 to 300 feet downgradient of the free product zone, concentrations are commonly nondetectable.

The pattern of substantial decreases in concentrations of constituents of concern over relatively short distances from the free product indicates that some degree of natural attenuation may be occurring in the groundwater system.

1.2 Objective

The objective of this report is to evaluate the extent to which natural attenuation is reducing the mass and concentration of constituents of concern in the groundwater at the site downgradient of the free product plume. This evaluation will help to assess whether natural attenuation of the constituents of concern could be an effective component in the overall site remediation strategy.

Section 2
Approach for Evaluation Natural Attenuation

Significant documents that present guidelines for evaluating natural attenuation in groundwater include the use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites (USEPA, 1999), ASTM Standard Guide for Remediation of Groundwater by Natural Attenuation at Petroleum Release Sites (ASTM, 1998), Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring For Natural Attenuation of Fuel Contamination Dissolved In Groundwater (Wiedemeier, et al., 1995), and Technical Protocol For Evaluating Natural Attenuation of Chlorinated Solvents In Ground Water (Wiedemeier et al., 1998). While dealing mainly with fuel-related constituents and chlorinated solvents, the technical protocols presented in these documents, are not strictly chemical-specific; rather, the approach is broadly applicable to a variety of contaminants where natural attenuation is being evaluated. The general technical protocol, outlined in the 1998 report (Wiedemeier et al., 1998) includes the following elements:

- Develop a preliminary conceptual model of contaminant behavior at the site
- Characterize the site hydrogeologic conditions
- Evaluate chemical indicators of natural attenuation
- Refine the conceptual model, and conduct pre-modeling calculations of contaminant behavior
- Simulate natural attenuation using a solute fate and transport model
- Conduct a receptor exposure pathways analysis
- Evaluate supplemental source removal options
- Prepare a long-term monitoring plan
- Present findings

These elements of a natural attenuation evaluation have been, or are being, addressed as follows. This report will present a preliminary conceptual model of contaminant behavior at the site, and additional data will then be used to refine the conceptual model. The site hydrogeologic conditions have previously been characterized in detail (Weston, 1992a) and are summarized briefly here. Chemical indicators of natural attenuation are evaluated in this report. Premodeling calculations of chemical behavior are presented, and natural attenuation simulations using a solute fate and transport model are presented in this report.

An exposure assessment completed previously for the site indicated no current human exposure pathway completed through groundwater under current conditions, although there was a potential for future use of groundwater identified for the site (Weston, 1992b). Source removal is currently ongoing at the site, in the form of EFR of free product. This source removal action follows removal of contaminated soil from the surface impoundment, and free product removal by extraction wells that was initiated in 1984. Finally, a long-term monitoring plan has been implemented for the site. A revised plan may be considered to track progress in natural attenuation of the contaminants, if natural attenuation becomes an important part of the overall remedial strategy.

The following sections present the results of conceptual model development, evaluation of natural attenuation indicators, premodeling calculations of contaminant behavior, and development of a fate and transport model to evaluate natural attenuation of key contaminants.

Section 3
Preliminary Conceptual Model

The key contaminants of concern in groundwater associated with the free product plume at the site include xylenes, ethylbenzene, and DEHP (NJDEP, 1994). The sources of these constituents are not well known, but leaks from the fuel oil tanks or lines that previously existed in the southern portion of the site are potential sources for xylenes and ethylbenzene. Xylenes were also used in the manufacturing process, and may have leaked from storage tanks or transfer lines located on-site. DEHP is an important component of plasticizers, and it may have been stored and used in the manufacturing process, and may have leaked from storage tanks or lines on-site. The on-site surface impoundment may have been a source of all three of the constituents listed above, since it contained waste materials from the site and was unlined.

Xylenes and ethylbenzene are readily biodegradable (Howard, 1989). Typically, xylenes and ethylbenzene are attenuated over very short distances away from a source. Evidence provided by Rice et al. (1995) from a study of 1,100 leaking underground storage tanks in California indicates that most BTEX plumes are stable or moving slowly relative to groundwater, and are limited by natural attenuation, especially involving biodegradation. Xylene- and ethylbenzene-degrading bacteria utilize electron acceptors for energy, such as (in order of preference) oxygen, nitrate, manganese, iron, and sulfate. Under aerobic (oxygen present) conditions, the biodegradation of ethylbenzene and xylenes will be most rapid; total removal of 7.5 mg/L total BTX (benzene, toluene, and xylenes) in 1.2 years was observed under aerobic conditions in shallow groundwater of one study (Barker et al., 1987). Under anaerobic conditions, xylenes and ethylbenzene are also readily degraded, but at a slower rate (Barker et al., 1987).

DEHP degrades rapidly under aerobic conditions in surface water, with half-lives of 2 to 3 weeks reported (Wolfe et al., 1980; Howard, 1989). Under anaerobic conditions in water sediment mixtures, no biodegradation has been reported in some studies (Howard, 1989). While there are few studies of DEHP biodegradation in groundwater reported in the literature, evidence indicates that, under aerobic conditions, a substantial degree of biodegradation will occur in groundwater, as it does in surface water (Howard, 1989). For example, Graves et al. (1994) reported substantial oxygen-limited biodegradation of DEHP concentrations by indigenous bacteria in laboratory microcosms simulating aerobic groundwater conditions and nutrient additions.

Examination of the distribution of xylenes, ethylbenzene, and DEHP in groundwater at the site shows a consistent pattern, in that concentrations are high close to the free product plume, and

decrease substantially over short distances away from the plume. Highest concentrations tend to be in the shallow groundwater, which is consistent with the free product plume being the source of dissolved constituents in the groundwater.

A preliminary conceptual model of the behavior of ethylbenzene (EH), xylenes (X), and DEHP at the site is that these constituents dissolve out of the free product plume and are carried downgradient in the groundwater. Groundwater flow downgradient of the free product is toward the north and east, toward the drainage ditch that extends east to west along the northern property line of the L.E. Carpenter site. The contaminants migrate laterally largely through the shallow groundwater, and are dispersed somewhat along the flow path. However, substantial decreases in concentration downgradient of the free product occur largely as a result of biodegradation of the three major constituents of concern, as well as other VOCs. The biodegradation occurs first under anaerobic, reducing conditions in the near vicinity of the free product, then under progressively oxidizing conditions downgradient of the free product. Within 200 to 300 feet of the downgradient edge of the free product, concentrations of X, E, and DEHP have decreased to nondetectable levels, as biodegradation has apparently removed the dissolved contaminants from the groundwater. Ten years of chemical data indicate that the plume of dissolved constituents of concern is relatively stable or shrinking over time, as free product is removed and the dissolved constituents are biodegraded along the flow path.

This preliminary conceptual model will be evaluated in consideration of the data and discussions provided in the following section. A refined conceptual model will be presented later in the report.

Section 4
Site Hydrogeologic Conditions

The hydrogeologic conditions of the site have been presented in the 1990 Report of Revised Investigation Findings, L.E. Carpenter & Company, by GeoEngineering, Inc., and in the 1992 Weston report entitled Final Supplemental Remedial Investigation Addendum for L.E. Carpenter and Company. In the western portion of the site, the upper stratum is composed largely of sand and gravel outwash, overlain by a thin layer of fill. In the eastern portion of the site, this outwash unit is overlain by relatively low-permeability silt and clay alluvium from the Rockaway River, that occurs within the upper 10 to 15 feet, based on the 1992 Weston Supplemental Remedial Investigation Report. However, later borings for EFR wells and recent exploratory borings identified a significant amount of sand and gravel in the upper alluvial unit at a number of locations within the free product zone that were previously identified as having silt alluvium. It appears that the upper alluvial unit is variable laterally, including areas of silty sand as well as silt and clay. Within the upper alluvial unit, borehole geophysics conducted at selected locations identified a silt/clay layer of variable thickness up to 2 to 5 feet, at depths ranging from about 5 to 10 feet. The upper alluvial unit of silt, sand, and clay overlies deeper permeable units (up to 170 feet total in thickness) composed of sand and gravel outwash and stratified drift.

Figure 3 shows a conceptual cross section of geologic conditions at the site, along an east-west transect. The cross section was modified slightly from Weston (1992) based on later data and extends through the free product zone, and through the downgradient monitoring locations in the groundwater plume. As shown in the cross section, geologic conditions are variable and complex at the site, with cross-cutting geologic contacts, geologic facies changes over short distances, and significant permeability differences across the site at various depths.

Free product occurs in the upper 15 feet of formation at the site, and in most cases is within 5 to 10 feet of the surface. At some locations, the free product occurs within shallow alluvium or fill, composed mainly of silt and clay, whereas at other locations it occurs within the silty sand.

Shallow groundwater flow is substantially affected by adjacent surface water bodies. Groundwater is recharged from the Rockaway River, and discharges into the drainage ditch that lies to the north and east of the free product zone. As shown on Figure 4, shallow groundwater flows from the free product area to the north and east, toward the drainage ditch that borders the site and the Air Products property. Except for the recharge zone adjacent to the

Rockaway River, vertical gradients are upward toward the shallow groundwater zone and surface water bodies.

The silty sand that occurs immediately beneath the surface (western portion of the site) or beneath the sandy silt/clay alluvium at depths ranging from 0 to 15 feet (eastern portion of the site) has a hydraulic conductivity of approximately 37 feet/day (Weston, 1992a). The hydraulic conductivity of the upper stratum of silt and clay alluvium that occurs in the eastern portion of the site has not been measured, but is likely on the order of 1 foot/day or less, based on boring log descriptions. The horizontal hydraulic gradient varies across the site, but is approximately 0.0016 ft/ft, based on examination of equipotential maps from GeoEngineering (1990), Weston (1992a), and RMT (1999). Assuming a typical effective porosity of 0.3 (Freeze and Cherry, 1979), the horizontal groundwater seepage velocity is approximately 73 ft/year in the shallow portion of the outwash sand.

Section 5
Extent of Groundwater Contamination

The extent of groundwater contamination with respect to free product, total BTEX, and DEHP is presented on Figures 5 and 6. Floating free product (also known as light nonaqueous-phase liquid, or LNAPL) exists over an area that is approximately 500 feet east-west by 100 feet north-south. In the free product area, concentrations of xylenes, ethylbenzene, and DEHP are generally high (several thousand µg/L); DEHP concentrations exceed the solubility limit of 285 µg/L at some locations (e.g., at MW-6R), either as a result of incorporation of free product into the water sample, or because the solubility of DEHP has been raised in the presence of other solvent constituents in the groundwater.

Total BTEX concentrations outside the free product area are generally nondetectable on the western and southwestern (upgradient) sides of the free product area, and are present at concentrations up to 9 mg/L to the east and north (downgradient) of the free product area (see Figure 5). The BTEX consists mainly of xylenes, with lesser concentrations of ethylbenzene. Benzene and toluene are generally not detectable in groundwater samples from the site (RMT, 1999). BTEX concentrations decrease substantially with distance away from the free product area; for example, along an easterly direction from the free product, the concentration of total BTEX decreases from 9 mg/L at MW-22, to 0.014 mg/L at MW-25, to less than 0.001 mg/L at MW-21 and MW-14.

DEHP shows a similar pattern to BTEX (Figure 6), with concentrations decreasing over short distances away from the free product plume. For example, concentrations of DEHP decrease from 0.67 mg/L at MW-22, to less than 0.001 mg/L at MW-25, MW-21, and MW-14I.

Concentrations of the constituents of concern are generally highest in the shallow groundwater, because of the proximity to the free product plume. Also, vertical gradients are generally upward along flowpaths originating from the free product area, which tends to keep the concentrations highest near the water table.

The historical record of contaminant concentrations shows that concentrations fluctuated seasonally over a wide range of values (see Table 1 and Figures 7a, 7b, and 7c). During the period from 1989 to 1992 when the remedial investigation was conducted, concentrations were relatively high in most monitoring wells. Concentrations decreased during the 1995 to 1996 period, then rose substantially during 1997, and have since decreased dramatically in downgradient wells. For example, xylene concentrations shown on Figure 7a show that concentrations in MW-22R decreased from 66,000 to 5,200 since 1997. Similarly, ethylbenzene

and DEHP concentrations have decreased dramatically at downgradient wells MW-22 and MW-25, since initiation of the EFR program late in 1997. The results indicate that the plume has shown seasonal fluctuations, but is now stable or decreasing over time.

Section 6
Natural Attenuation Chemical Indicators

Biodegradation of organic contaminants involves redox (oxidation/reduction) reactions, whereby an electron is transferred from the organic contaminant to an electron acceptor. The highest energy potential, and thus the most preferred pathway, is obtained from using oxygen as the electron acceptor, which occurs under aerobic conditions. If oxygen is absent, various other electron acceptors can be used to provide energy needed to degrade the contaminant. Table 2 shows various electron acceptors, including oxygen, nitrate, iron, sulfate, and carbon dioxide, in order of energy derived (and preference), from highest to lowest. In nature, usually more than one of the electron acceptors are available in the groundwater at any zone. This is because some of the redox reactions have similar energy values, such that more than one reaction is likely to occur at any point. Also, microenvironments present in the subsurface around particulate carbon, iron minerals, etc., cause a range of redox conditions to exist even in a small zone, such as that sampled by a monitoring well. Generally, there are overlapping ranges of the various electron acceptors, such that groundwater samples usually contain more than one of the electron acceptors.

Indicators of natural attenuation of petroleum hydrocarbons (such as xylenes and ethylbenzene) and DEHP, which are degraded primarily under oxidative pathways, include absence or decreased concentrations of dissolved oxygen, nitrates, and potentially sulfate, depressed electrode millivolt values of redox, increased concentrations of CO_2, nitrite or ammonia, dissolved iron, and potential hydrogen sulfide and methane, relative to background (Wiedemeier et al., 1995).

Table 3 presents the concentrations of indicator parameters of natural attenuation. Figures 8, 9, and 10 show the distribution of dissolved oxygen, redox potential, and ferrous iron in groundwater samples. Laboratory data sheets are presented in Appendix A.

Figure 8 shows the depressed concentrations of dissolved oxygen that occur in the vicinity of the free product, and extending downgradient of the free product, to the east and north. Concentrations below 0.5 mg/L of dissolved oxygen typify the area near to, and within, the free product zone, whereas concentrations above 1 mg/L occur in upgradient locations. Because of the difficulty in preventing diffusion of oxygen into groundwater samples during sample collection, the low values of oxygen shown on the figure are probably maximum values.

The distribution of redox potential values in groundwater over the site is shown on Figure 9. In the upgradient (western) end of the site, values of redox potential are positive. Reduced redox

conditions, indicated by negative redox electrode values, occur in the vicinity of the free product zone, and extend downgradient to the east and north, toward the Drainage Channel and monitoring well MW-25. The negative redox values correspond approximately with values of dissolved oxygen less than 1.0 mg/L.

Ferrous iron values in groundwater are presented on Figure 10. Ferrous iron is the chemically reduced form of iron, which is far more soluble. High ferrous iron concentrations are indicative of reducing conditions in the groundwater. Although few in number, the values are consistent with the information provided by dissolved oxygen and redox potential, with indications of oxidized conditions upgradient of the free product zone, and reduced conditions downgradient (east) of the free product.

Table 3 shows the concentrations of other indicators of natural attenuation, general chemistry, and nutrients for biodegradation. Nitrate, which after oxygen is the most preferred electron acceptor utilized by bacteria under oxidizing conditions, is nondetectable in downgradient monitoring wells MW-6R, WP-B6, WP-B10, MW-2R, MW-22R, and WM-25R, again providing evidence of reducing chemical conditions downgradient of the free product. Sulfate concentrations are also substantially reduced in downgradient monitoring well samples. Sulfate becomes reduced to sulfide under very reducing conditions. Methane, a by-product of microbial respiration, is an indicator of microbial activity and also an indicator of chemically reducing conditions. Concentrations greater than 1 mg/L of methane were detected in groundwater samples from monitoring wells that are located downgradient of the free product plume (MW-6R, WP-B6, WP-B10, MW-2R, MW-22R, and MW-25R). For upgradient wells MW-15S, WP-A3, and MW-17S, methane was nondetectable or was present at a concentration of less than 0.1 mg/L.

Bacterial plate counts of water samples from monitoring wells show that high numbers of heterotrophic bacteria colonies are present downgradient of the free product. Over 1,000 colonies/mL were counted in downgradient monitoring well samples. The results of the bacteria plate counts are presented in Appendix A.

Thus, a number of chemical indicators, including dissolved oxygen, redox potential, ferrous iron, methane, nitrate, and sulfate, show that various electron acceptors were depleted in concentration beneath and downgradient of the free product plume, relative to upgradient locations. Downgradient of the free product, conditions are chemically reducing, whereas oxidizing conditions are present at upgradient locations. Heterotrophic bacteria colonies are present at substantially higher numbers in water samples from downgradient of the free product, than in groundwater from upgradient locations. These patterns are consistent with a conceptual model of depleted concentrations of various electron acceptors, such as oxygen, nitrate, sulfate, and carbon dioxide, that are used for energy as the bacteria degrade xylenes,

ethylbenzene, and DEHP. As the groundwater migrates farther downgradient toward MW-22R and MW-25R, the concentrations of the electron acceptors begin to rise again as the groundwater becomes depleted with the contaminants.

Section 7
Bioscreen Fate and Transport Modeling

Fate and transport modeling was conducted to evaluate the behavior of dissolved constituents of concern in the groundwater. Downgradient of the free product zone, concentrations of three major constituents of concern, xylenes, ethylbenzene, and DEHP, decrease from values in the thousands of µg/L to below detectable concentrations, over distances of less than 300 feet. Along the same flowpaths, various indicators of biodegradation, including bacteria colony populations, dissolved oxygen, methane, and others are consistent with conditions that would be expected if significant biodegradation were occurring. In this section, changes in the concentrations of the three major constituents of concern along a flowpath are quantified, to evaluate the rate at which the contaminants are being removed from the groundwater.

The shallow groundwater piezometric surface elevation for the 4th quarter of 1999 is mapped on Figure 4. Local groundwater gradients in the shallow portion of the outwash are from the free product zone eastward and northward, toward the Drainage Channel shown on Figure 4. The direction of the apparent hydraulic gradient varies seasonally, with the gradient being directed more easterly or northerly from one period to another. The actual flowpath of groundwater may be skewed more easterly than the hydraulic gradient, based on the pattern of concentrations observed in monitoring wells between the free product and the drainage ditch. For example, from the MW-6 location, it appears that the groundwater flow may be directed eastward toward MW-22, based on higher concentrations at MW-22 than at MW-2 or WP-B10, which are located north of MW-6. Anisotropy of hydraulic conductivity caused by geologic stratification oriented easterly (along the direction of the Rockaway River) can easily cause a preferential flowpath to be skewed easterly (Freeze and Cherry, 1979).

Based on hydraulic head data and concentration patterns, monitoring wells MW-6, MW-22, and MW-25 lie along a generalized flowline that starts at the free product zone and extends eastward, and then northward, toward the Drainage Channel. The position of these three monitoring wells along the generalized flowline, along with availability of monitoring data, makes them useful for evaluating the rate of change of contaminants in the groundwater. An alternate flowpath, northward between MW-6 and MW-2, was also considered in the evaluation of biodegradation.

Groundwater chemical data that were reported in the Supplemental Remedial Investigation Report (Weston, 1992a) are used in this evaluation, because the three monitoring wells (MW-6, MW-22, and MW-25) that lie along the designated downgradient flowline were sampled at that

time (between 1990 and 1992). Recent groundwater data (from April 2000) were also used in this evaluation, and show that the pattern of decreasing concentrations over distance are consistent over the past decade. As shown in Table 1, in the early 1990s, xylene concentrations decreased from 120,000 µg/L at MW-6, to 18,000 µg/L at MW-22, and to less than detection at MW-25. In the same three wells, concentrations of ethylbenzene decreased from 16,000 µg/L to 3,200 µg/L to less than detection. Similarly, DEHP concentrations decreased from 62,000 µg/L at MW-6 to 8 µg/L at MW-25. No DEHP data were available for MW-22 in the 1990 to 1992 sampling period. A similar pattern of sharp decreases of concentration over distance has continued to the present, as shown in Table 1, for monitoring wells WM-6, MW-22, and MW-25.

7.1 Model Code

The analytical screening model for evaluating natural attenuation, Bioscreen (Newell et al., 1996), was used to estimate degradation rates in the groundwater for the three major contaminants in groundwater downgradient of the free product zone: xylenes, ethylbenzene, and DEHP. The Bioscreen model was developed through a cooperative effort between the U. S. Air Force Center for Environmental Excellence and the USEPA. Bioscreen has the ability to simulate one-dimensional advection, two-dimensional dispersion, sorption, and various types of degradation reactions of contaminants that are evaluated. Bioscreen can simulate solute transport without decay, linear (first-order) rate of degradation, or "instantaneous" degradation by reacting the contaminant with rate-limiting nutrients such as dissolved oxygen at specified ratios. Both aerobic and anaerobic reactions can be simulated.

7.2 Model Input Parameters

It is recognized that there is no unique set of parameters that can be identified definitively for the entire site. In nature, there is always uncertainty associated with parameter estimates for any given site. Two sets of model input parameters were used to simulate the transport and fate of xylenes, ethylbenzene, and DEHP, in order to account for uncertainty in several of the input parameters. By utilizing two sets of input parameters that bracket a likely range of parameter values, the results derived from each parameter set can be compared to determine if the conclusions would change if the model were calibrated to a different set of parameters that were used within a likely range for the parameters.

Measured values of hydraulic conductivity and hydraulic gradient were used to calculate the groundwater seepage velocity for the model, as discussed above. The resulting groundwater seepage velocity is calculated to be 73 feet per year. This value was utilized in both Parameter Sets 1 and 2.

The advective migration of the three dissolved contaminants is governed by the groundwater seepage velocity and by retardation due to sorption to aquifer solids. Because the total organic carbon content of the aquifer was not quantified, a site-specific partition coefficient for each contaminant cannot be defined accurately. An estimated value of 0.1 percent organic carbon in the aquifer soil was used to estimate the degree of sorption, and the retardation of each contaminant. A review of literature values for organic carbon reveals that the value of 0.1 percent carbon is a typical value that is useful for estimating the degree of sorption in the aquifer. The 0.1 percent carbon value, and the resulting values for sorption and retardation for each constituent, were kept constant for Parameter Sets 1 and 2.

In Parameter Set 1, the "source" of each contaminant was conservatively simulated as having a large mass, thus representing a large, slowly diminishing source. This conservative approach assumes that the free product is the source of the xylenes, ethylbenzene, and DEHP, and that the free product will remain as a source for a number of years. This approach is conservative but reasonable, because, although the free product is being actively removed at the site, it is likely that some free product will still remain for several years, and will serve as a source for the dissolved contaminants.

The model was calibrated to historical concentrations of xylenes, ethylbenzene, and DEHP along a flowline located downgradient of the free product on site. The selected flowline starts in the free product zone at MW-6, and extends to MW-22 and then to MW-25.

Model input parameters are listed in Table 4, and on Figures 10a, 11a, and 12a for xylenes, ethylbenzene, and DEHP, respectively. In each case, the groundwater seepage velocity (average linear velocity) along the selected flowline is designated as 73 ft/yr, as discussed in Section 4.

The retardation factor due to sorption was calculated for each of the three constituents that were simulated, based on the following equation:

$$R = 1 + (p_b/n_e)(K_{oc})$$

where R= retardation coefficient, p_b = bulk mass density, n_e = effective porosity, and K_{oc} = partitioning coefficient for each contaminant to organic carbon. The retardation values were calculated based on literature values for K_{oc} (Wiedemeier et al., 1995; Howard et al., 1990), estimated bulk mass density (Freeze and Cherry, 1979), and an estimated concentration of 0.1 percent organic carbon in the aquifer soil, as discussed in Section 4. Resulting retardation coefficient values were 3.4 for xylenes and 4.0 for ethylbenzene. A calculated retardation coefficient of 601 for DEHP (based on its strong tendency to adsorb) produced resulting concentration distributions that could not be calibrated to observed concentrations; therefore, the retardation coefficient was reduced substantially to 9, in order to calibrate the model to

observed concentrations at the site. This approach is justified because DEHP occurs with organic solvents (notably xylenes and ethylbenzene), which can substantially increase the solubility and decrease the tendency of DEHP to adsorb to aquifer solids (USDHHS, 1993).

The biodegradation first order decay constant was a major calibration parameter that was adjusted during the modeling simulations to derive a best fit of simulated concentrations to the observed data. The decay constants used in the calibrated models for Parameter Sets 1 and 2 varied from 1.2/year for xylenes, to 0.8/year for ethylbenzene, and 0.3/year for DEHP.

The simulation time for the model was set at 30 years. The actual dates or period over which contaminant releases might have occurred is not known; however, it is likely that the releases occurred prior to 1982, and after operations began in 1943.

The source thickness was set at 10 feet, based on the tendency of the highest concentrations to be strongly focused in the upper 10 feet of the of the aquifer. The source concentration at the center of the plume was adjusted during calibration to derive a reasonable fit to observed concentrations especially at the source area (MW-6), after a 30-year simulation time since the release.

The source mass and source half-life were also adjusted during calibration to provide a reasonable fit to the observed data. Source mass values for xylenes, ethylbenzene, and DEHP were conservatively assumed to be infinite for Parameter Set 1, and were set at 70,000, 10,000, and 100,000 kg for Parameter Set 2. The total mass values of xylenes, ethylbenzene, and DEHP in the aquifer include the amount present as free product, and the amount sorbed onto soil. These amounts are not known with accuracy; however, the mass values used in the model were adjusted in conjunction with the source concentration terms and biodegradation reaction rates, to achieve a reasonable fit to the observed concentrations on site. If most of the source mass of the three constituents is present in the free product, the combined source mass of these three constituents is constrained by the volume of free product at the site. Based on estimates conducted recently (RMT, 1999), the free product source mass is estimated to be approximately 44,000 gallons (equivalent to approximately 160,000 kg if the average density is 0.94). Of the total mass of 160,000 kg of free product, some is likely composed of different constituents than the three constituents simulated here. Analyses of free product samples taken in 1995 from monitoring wells MW-1R, MW-11S, and MW-6R indicated that the free product was composed of approximately 35 percent DEHP, 20 percent xylenes, and 4 percent ethylbenzene (Weston, 1995), based on mean concentrations of three samples. Considering these analytical results, and an estimated free product mass of 160,000 kg, the Parameter Set 2 source mass values are reasonable and realistic estimates of the mass of DEHP, xylenes, and ethylbenzene at the source.

The simulations that were conducted using Parameter Sets 1 and 2 both conservatively simulate the source mass estimates at the site. In Parameter Set 1, the source mass is assumed to be infinite. In Parameter Set 2, the source mass is set at 70,000 kg for xylenes, 10,000 kg for ethylbenzene, and 100,000 kg for DEHP. Together, the three constituents total a mass of 180,000 kg in Parameter Set 2, which exceeds the estimate for total mass of free product at the site, 160,000 kg.

7.3 Model Results

Results of the Bioscreen modeling of xylenes, ethylbenzene, and DEHP are illustrated on Figures 11a-c, 12a-c, and 13a-c for Parameter Set 1, and Figures 14a-c, 15a-c, and 16a-c for Parameter Set 2. As shown on Figure 11b, Parameter Set 1 values result in a reasonable fit to the observed xylenes concentration data at the source (MW-6, located 0 feet downgradient) and at MW-25, located approximately 300 feet downgradient. The observed concentration of xylenes at MW-22, located approximately 220 feet downgradient, is somewhat higher than predicted by the model, and the higher concentration observed at that location probably reflects a lower rate of biodegradation closer to the source, where anaerobic conditions predominate. It is likely that the rate of biodegradation increases in the downgradient direction (toward MW-25), as conditions become more oxidizing away from the free product. Research has shown that aerobic conditions are necessary for biodegradation of DEHP to occur, and aerobic conditions greatly enhance the rate of biodegradation of xylenes and ethylbenzene (Howard, 1989; USDHSS, 1993).

The model results indicate that, if there were no degradation of xylenes at the site, the expected concentration of xylenes 320 feet downgradient of the source (at MW-25) would be approximately 135 mg/L (see Figure 11b); actual concentrations observed were less than 0.001 mg/L. As shown on Figure 11c, the actual dissolved xylene mass in the plume is estimated to be 85 kg, compared to a calculated value of 4,075 kg if there were no biodegradation. Thus, the model results indicate that approximately 98 percent of the dissolved xylenes have biodegraded over the past 30 years, resulting in the low concentrations at the downgradient portion of the attenuated plume that occurs today.

based on an infinite source & a high assumed degradation rate

The results from Parameter Set 2 for xylenes are similar to those from Parameter Set 1, as shown on Figures 14b and 14c. The Parameter 2 model results indicate that the calculated dissolved mass of xylenes in the plume is 87 kg, compared to a calculated dissolved mass of xylenes of approximately 3,600 kg if there were no biodegradation. As with Parameter Set 1, the model results indicate that approximately 98 percent of the dissolved mass of xylenes was biodegraded over the past 30 years.

The results of Bioscreen modeling of ethylbenzene using Parameter Set 1, shown on Figures 12b and 12c, indicate that an actual dissolved mass of ethylbenzene in the groundwater plume is approximately 10 kg, compared to a calculated dissolved mass of 832 kg if there were no biodegradation. A 99 percent removal of dissolved ethylbenzene by biodegradation is estimated. Ethylbenzene modeling using Parameter Set 2 is summarized in Table 4 and on Figures 15a, 15b, and 15c. Similar to the results using Parameter Set 1, a dissolved plume mass of 16 kg ethylbenzene is calculated, compared to an estimated 500 kg of dissolved ethylbenzene after 30 years, if there were no biodegradation. The results for Parameter Set 2 indicate a 97 percent removal of dissolved ethylbenzene by biodegradation, compared to 99 percent using Parameter Set 1.

DEHP model results are shown on Figures 13b and 13c, for Parameter Set 1. With an infinite source assumed, a plume mass of approximately 3,600 kg of DEHP is calculated by the model after a 30-year period, if there were no biodegradation. The actual dissolved mass of DEHP in the plume is calculated to be 88 kg, a reduction of 98 percent that is attributed to biodegradation. Using Parameter Set 2 with a finite source mass of 100,000 kg, the model results indicate that 1,860 kg of DEHP would be dissolved in the plume after 30 years, if there were no biodegradation (see Figures 16a, 16b, and 16c). The actual mass of DEHP dissolved in the plume is calculated to be 54 kg, a reduction of 97 percent attributed to biodegradation.

Bioscreen modeling was also conducted along a second potential flowline, between MW-6 and MW-2. Chemical data from the 1992a Weston report was used to evaluate the degree of biodegradation that may be occurring in the aquifer. Model input and output details for xylenes, ethylbenzene, and DEHP are summarized on Figures 17a-c, 18a-c, and 19a-c. Similar to the MW6/MW22/MW25 flowpath, the reduction in concentrations of xylenes, ethylbenzene, and DEHP between MW6 and MW2 is substantial, such that concentrations are reduced to 1/100 or less of the source concentration over a distance of approximately 100 feet.

Current conditions at the site were also simulated, using the same Parameter Set 1 values that were used to simulate 1990-1992 conditions. The reaction rates from the previous simulations were held constant, along with all other Parameter Set 1 values; only the source concentration terms were adjusted to simulate current concentrations at MW-6R. Concentrations of the major constituents of concern (xylenes, ethylbenzene, and DEHP) showed a familiar pattern of sharply decreasing values in April 2000, along the MW6R/MW-22R/MW-25R flowline, as seen previously.

The results of the Bioscreen modeling of current concentrations are shown on Figures 20a-c, 21a-c, and 22a-c. The results indicate that a reasonable fit to the current data was obtained using Parameter Set 1 values. Although an improved fit to the observed data could be derived by adjusting the reaction rates slightly, the fit is reasonably good using the Parameter Set 1

values. This indicates that the rates of reaction at the site are relatively stable over time. Additional simulations of April 2000 conditions for the alternate flowline (MW-6R/MW-2R) are presented on Figures 23a-c, 24a-c, and 25a-c for xylenes, ethylbenzene, and DEHP. Using the same Parameter Set 1 values, the model was again able to simulate current conditions at the site reasonably well.

The Bioscreen modeling results indicate that a substantial degree of biodegradation is occurring in the aquifer, resulting in the attenuated plume of xylenes, ethylbenzene, and DEHP that is observed today. Using two different sets of aquifer parameter values that bracket likely conditions at the site, the model results indicate approximately 97 percent or more of the dissolved mass of xylenes, ethylbenzene, and DEHP has been removed by biodegradation. Along a second possible flowpath, Bioscreen modeling also indicates that approximately 98 percent of the dissolved mass of xylenes, ethylbenzene, and DEHP has been biodegraded.

Independent evidence that the groundwater contaminant plume is attenuated before it reaches the drainage ditch located downgradient of the plume is provided by analyses of surface water samples. Analytical results from samples from locations SW-5-1, SW-7-1, and SW-8-1 (see Figure 2) indicate that there were no detectable concentrations of DEHP, xylenes, or ethylbenzene in any of the three samples (RMT, 1998).

Prediction modeling that simulates future plume concentrations was conducted, based on the calibrated model presented above. This modeling tests whether the plume is likely to advance or be stable over time. Concentrations in the plume 20 years into the future were calculated using a conservative assumption of an infinite source. For the MW6/MW22/MW25 flowpath, the model results for xylenes are summarized on Figures 26a-c. Even with the conservative assumption of an infinite source, the results indicate that the xylene plume would be stable, and would not advance. Similar results were obtained for ethylbenzene and DEHP. Actual decreases in source mass, which are occurring due to source recovery actions, would tend to decrease the predicted concentrations in the plume over time, once the source mass became depleted such that dissolved concentrations at the source decrease significantly.

These results are consistent with findings at numerous other sites and laboratory studies, where substantial biodegradation of xylenes, ethylbenzene, and DEHP (under aerobic conditions) have been documented. While there is some uncertainty in the values of several of the aquifer parameters, the fact that similar estimates of biodegradation were obtained using two parameter sets that bracket the range of likely conditions at the site strongly suggests that substantial biodegradation is occurring, and is removing more than 95 percent of the dissolved mass of xylenes, ethylbenzene, and DEHP.

Section 8
Refined Conceptual Model of the Behavior of Constituents of Concern

The conceptual model of the transport and fate of xylenes, ethylbenzene, and DEHP in the aquifer at the L.E. Carpenter site can now be refined based on evidence from biodegradation indicators and biodegradation modeling. The evidence indicates that substantial reductions to nondetectable or near nondetectable concentrations of all three of the targeted constituents occur over flowpaths of 300 feet or less. There is evidence that the rate of biodegradation increases down the flowpath, as conditions become less reducing chemically and oxygen becomes more available to degrading microbes. Although there is a substantial source in the form of free product at the site, the source is being removed with EFR methods, and the dissolved plume is attenuating over short distances. A conservative Bioscreen assessment of the plume using an assumption of an infinite source indicates that more than 95 percent of the dissolved xylenes, ethylbenzene, and DEHP are removed from the plume over flowpaths of 300 feet or less. Furthermore, concentration trends downgradient of the plume are generally decreasing over time. In total, the evidence from groundwater monitoring and modeling indicates that natural attenuation processes, especially biodegradation, are effective at reducing plume concentrations such that the plume is very restricted in length, and is stable or decreasing over time.

Section 9
References

ASTM, 1998. Standard Guide for Remediation of Groundwater by Natural Attenuation at Petroleum Release Sites. ASTM E 1943-98.

Barker, J.F., G. Patrick, and D. Major, 1987. Natural attenuation of aromatic hydrocarbons in a shallow sand aquifer. Groundwater Monitoring Review, Winter 1987, pp. 64-71.

Freeze, A. and J. Cherry, 1979. Groundwater. Prentice-Hall, Inc. New Jersey.

GeoEngineering, Inc., 1990. Report of Revised Remedial Investigation Findings, L.E. Carpenter & Company, Wharton, New Jersey Site.

Graves, D.A., C.A. Lang, and J.N. Rightmyer, 1994. Biodegradation of bis(2-ethylhexyl)phthalate, ethylbenzene, and xylenes in groundwater: Treatability study supporting *in situ* aquifer bioremediation. *In* Proceedings of Second International Conference on *In situ* and On Site Bioreclamation.

Howard, P.H., 1989. Handbook of Environmental Fate and Exposure Data for Organic Chemicals., Vol. I. Large Production and Priority Pollutants. Chelsea, MA, Lewis Publishing.

Newell, C., R. K. McLeod, and J. Gonzales, 1996. Bioscreen - Natural Attenuation Decision Support System, User's Manual, ver. 1.3. EPA/600/R-96/087.

NJDEP (New Jersey Department of Environmental Protection), 1994. Superfund Record of Decision, L.E. Carpenter/Dayco Corporation Site, Wharton Borough, Morris County, New Jersey. April, 1994.

Rice, D.W., R.D. Grose, J.C. Michaelsen, B.P. Dooher, D.H. MacQueen, S.J. Cullen, W.E. Kastenberg, L.G. Everett, and M.A. Marino, 1995. California Leaking Underground Fuel Tank (LUFT) Historical Case Analyses: California State Water Resources Control Board.

RMT, 1998. Second Quarter 1998 Quarterly Monitoring Report. September, 1998.

RMT, 1999. Quarterly Monitoring Report, 2nd Quarter, 1999, L.E. Carpenter. July 1999.

USDHHS (United States Department of Health and Human Services, Public Health Services, Agency for Toxic Substances and Disease Registry), 1993. Toxicological Profile for Di (2-Ethylhexyl) Phthalate.

USEPA, 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. OSWER Directive 9200.4-17P.

Weston, 1992a. Final Supplemental Remedial Investigation Addendum for L.E. Carpenter and Company. July, 1992.

Weston, 1992b. Baseline Risk Assessment, L.E. Carpenter and Company, Wharton, New Jersey. January 1992.

Weston, 1995. Quarterly Progress Report, L.E. Carpenter Site, Wharton, New Jersey. Vol. 1 of 2. April, 1995.

Wiedemeier, T., J. T. Wilson, D. Kampbell, R. Miller, and J. Hansen, 1995. Technical protocol for implementing intrinsic remediation with long-term monitoring for natural attenuation of fuel contamination dissolved in groundwater: U.S. Air Force Center for Environmental Excellence, San Antonio, TX.

Wiedemeier, T., M. Swanson, D. Montoux, E.K. Gordon, J. T. Wilson, B. Wilson, D. Kampbell, P. Haas, R. Miller, J. Hansen, and F. Chappelle, 1998. Technical protocol for evaluating natural attenuation of chlorinated solvents in ground water: U.S. Environmental Protection Agency National Risk Management Research Laboratory, Cincinnati, OH.

Wolfe, N. L., D.F. Paris, W.C. Steen et al., 1980. Correlation of microbial degradation rates with chemical structure. Environmental Science and Technology, Vol. 14, pp. 1143-1146.

Table 1
Groundwater Monitoring Data
L. E. Carpenter - Wharton, New Jersey

MONITORING WELLS	SAMPLING DATE		CHEMICAL ANALYSIS RESULTS				
	YEAR	QUARTER	Benzene µg/L	Ethylbenzene µg/L	Toluene µg/L	Total Xylenes µg/L	bis-2- Ethylhexylphthalate (DEHP) µg/L
NJDEP GWQS			1	700	1,000	40	30
ROD DISCHARGE CRITERIA			1	350	500	20	30
MW-4	1989	3	ND	ND	1.7 J	17	ND
	1990	1	ND	ND	ND	ND	3.6
	1995	1	ND	26	ND	32	**25,000**
		2	ND	16	ND	13	**46,000**
		3	ND	9.7	ND	8.7	NS
		4	ND	8.8	ND	11	**17,000**
	1996	1	ND	24	ND	**47**	NS
		2	NS	NS	NS	NS	NS
		3	ND	6.8	ND	4.3	NS
		4	ND	2.3	ND	ND	**11,000**
	1997	1	ND	3.5	ND	1.8	NS
		2	ND	1.2	ND	4.2	**120**
		3	ND	2.2	ND	12.6	NS
		4	NS	NS	NS	NS	NS
	1998	1	ND	ND	ND	ND	NS
		2	ND	1.0	ND	1.4	**710**
		3	ND	1.9	ND	1.2	NS
		4	ND	9.3	ND	3.3	**650**
	1999	1	ND	1.1	ND	2.5	NS
		2	ND	0.66	ND	ND	**3,000**
		2 duplicate	ND	0.43	ND	ND	**4,400**
		3	ND	3.10	ND	2.9	NS
		4	ND	0.51	ND	ND	**4,000**
	2000	1	ND	0.54	ND	1.6	NS
		2	ND	0.30	ND	ND	**480**
MW-11I	1989	3	ND	ND	88	700	ND
	1990	1	ND	ND	ND	12	ND
MW-11(IR)	1999	1	ND	ND	ND	0.8	ND
		2	NS	NS	NS	NS	NS
		3	NS	NS	NS	NS	NS
MW-11D	1989	3	ND	ND	ND	ND	ND
	1990	1	ND	ND	ND	ND	3,600 D
MW-11(DR)	1999	1	ND	ND	ND	ND	**64**
		1 duplicate	ND	ND	ND	ND	20
		2	NS	NS	NS	NS	NS
		3	NS	NS	NS	NS	**59**
		3 duplicate	NS	NS	NS	NS	13
		4	ND	ND	ND	ND	ND

Table 1
Groundwater Monitoring Data
L. E. Carpenter - Wharton, New Jersey

MONITORING WELLS	SAMPLING DATE		CHEMICAL ANALYSIS RESULTS				
	YEAR	QUARTER	Benzene µg/L	Ethylbenzene µg/L	Toluene µg/L	Total Xylenes µg/L	bis-2-Ethylhexylphthalate (DEHP) µg/L
NJDEP GWQS			1	700	1,000	40	30
ROD DISCHARGE CRITERIA			1	350	500	20	30
MW-11(DR) (continued)	2000	1	ND	ND	ND	ND	ND
		2	ND	ND	ND	ND	ND
		2 duplicate	ND	ND	ND	ND	NR
MW-14I	1989	3	ND	ND	ND	ND	ND
	1990	1	ND	ND	ND	ND	ND
	1995	1	ND	0.4	ND	1.2	140
	1995	2	ND	ND	ND	ND	1.6
	1995	3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	2.6
	1996	1	ND	ND	ND	ND	NS
		2	NS	NS	NS	NS	NS
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	2.7
	1997	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	1.6
		3	1.2	22.1	ND	176	NS
		4	NS	NS	NS	NS	NS
	1998	1	ND	ND	ND	ND	NS
		2	ND	0.34	ND	2	24
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	ND
	1999	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	ND
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	ND
	2000	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	ND
MW-15S	1989	3	ND	1.9	ND	ND	ND
	1990	1	ND	ND	ND	ND	ND
	1995	1	ND	ND	ND	ND	2.4
		2	ND	ND	ND	ND	ND
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	ND
	1996	1	ND	33	ND	83	NS
		2	NS	NS	NS	NS	NS
		3	ND	ND	ND	ND	NS
		4	ND	0.21	ND	1.7	ND
	1997	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	1.2
		3	ND	ND	ND	ND	NS

Table 1
Groundwater Monitoring Data
L. E. Carpenter - Wharton, New Jersey

MONITORING WELLS	SAMPLING DATE		CHEMICAL ANALYSIS RESULTS				
	YEAR	QUARTER	Benzene µg/L	Ethylbenzene µg/L	Toluene µg/L	Total Xylenes µg/L	bis-2-Ethylhexylphthalate (DEHP) µg/L
NJDEP GWQS			1	700	1,000	40	30
ROD DISCHARGE CRITERIA			1	350	500	20	30
MW-15S (continued)		4	NS	NS	NS	NS	NS
	1998	1	ND	ND	1.4	ND	NS
		2	ND	ND	ND	1.3	ND
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	ND
	1999	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	ND
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	ND
	2000	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	ND
MW-15I	1989	3	ND	1.6	ND	ND	ND
	1990	1	ND	ND	ND	ND	ND
	1995	1	ND	ND	ND	ND	250
		2	ND	ND	ND	ND	7.2
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	2.8
	1996	1	ND	ND	ND	ND	NS
		2	NS	NS	NS	NS	NS
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	1.7
		4 duplicate	ND	ND	ND	ND	1.9
	1997	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	2.2
		3	ND	ND	ND	ND	NS
		4	NS	NS	NS	NS	NS
	1998	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	1.9
		2 duplicate	ND	ND	ND	ND	3.8
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	0.53	11
		4 duplicate	ND	0.2	ND	0.8	9.8
	1999	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	4.8
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	ND
	2000	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	ND

Table 1
Groundwater Monitoring Data
L. E. Carpenter - Wharton, New Jersey

MONITORING WELLS	SAMPLING DATE		CHEMICAL ANALYSIS RESULTS				
	YEAR	QUARTER	Benzene µg/L	Ethylbenzene µg/L	Toluene µg/L	Total Xylenes µg/L	bis-2-Ethylhexylphthalate (DEHP) µg/L
NJDEP GWQS			1	700	1,000	40	30
ROD DISCHARGE CRITERIA			1	350	500	20	30
MW-17S	1989	3	ND	2.5 J	ND	ND	ND
	1990	1	ND	ND	ND	ND	ND
	1995	1	ND	0.6	0.3	1.9	11
		2	0.2	ND	0.18	ND	ND
		3	NS	NS	NS	NS	NS
		4	ND	ND	ND	0.63	ND
	1996	1	NS	NS	NS	NS	NS
		2	NS	NS	NS	NS	NS
		3	NS	NS	NS	NS	NS
		4	ND	ND	ND	ND	1.5
	1997	1	NS	NS	NS	NS	NS
		2	ND	ND	ND	ND	NS
		3	NS	NS	NS	NS	NS
		4	NS	NS	NS	NS	NS
	1998	1	NS	NS	NS	NS	NS
		2	ND	ND	ND	1.2	6.1
		3	NS	NS	NS	NS	NS
		4	ND	ND	ND	ND	6
	1999	1	NS	NS	NS	NS	NS
		2	ND	ND	ND	ND	ND
		3	NS	NS	NS	NS	NS
		4	ND	ND	ND	ND	40
	2000	1	NS	NS	NS	NS	NS
		2	ND	ND	ND	ND	ND
MW-21	1991	3	ND	ND	ND	ND	ND
	1999	1	ND	ND	ND	ND	ND
		2	ND	ND	ND	ND	ND
		3	ND	ND	ND	ND	ND
		4	ND	ND	ND	ND	ND
	2000	1	ND	ND	ND	ND	6
		1 duplicate	NS	NS	NS	NS	ND
		2	ND	ND	ND	ND	ND
MW-22	1992	1	ND	ND	3,200	18,000	NS
	1995	1	ND	57	ND	**260**	**6,500**
		2	ND	311	ND	**955**	**380**
		3	ND	171	ND	**693**	NS
		4	ND	123	ND	**494**	**320**

Table 1
Groundwater Monitoring Data
L. E. Carpenter - Wharton, New Jersey

MONITORING WELLS	SAMPLING DATE		CHEMICAL ANALYSIS RESULTS				
	YEAR	QUARTER	Benzene µg/L	Ethylbenzene µg/L	Toluene µg/L	Total Xylenes µg/L	bis-2-Ethylhexylphthalate (DEHP) µg/L
NJDEP GWQS			1	700	1,000	40	30
ROD DISCHARGE CRITERIA			1	350	500	20	30
MW-22 (continued)	1996	1	NS	NS	NS	NS	NS
		2	NS	NS	NS	NS	NS
		3	ND	359	ND	1,320	NS
		4	ND	320	ND	1,330	ND
	1997	1	NS	NS	NS	NS	NS
		2	ND	5,730	ND	32,900	7,500
		3	ND	11,400	348	66,000	NS
		4	NS	NS	NS	NS	NS
	1998	1	ND	4,070	348	20,600	NS
		2	ND	2,260	ND	11,300	5,800
		3	ND	ND	ND	ND	NS
		3 duplicate	ND	2,510	ND	11,000	NS
		4	ND	1,650	ND	7,230	1,100
	1999	1	ND	18	ND	84	NS
		2	ND	1,600	ND	7,600	670
		3	ND	1,200	42	5,200	NS
		4	ND	810	ND	3,300	1,200
		4 duplicate	ND	840	ND	3,400	1,600
	2000	1	ND	360	ND	1,400	NS
		2	ND	820	ND	3,600	92
MW-25	1992	1	ND	ND	ND	ND	8 J B
	1995	1	NS	NS	NS	NS	NS
		2	ND	ND	ND	ND	1.6
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	68
	1996	1	NS	NS	NS	NS	NS
		2	NS	NS	NS	NS	NS
		3	ND	0.34	ND	2.2	NS
		4	ND	ND	ND	ND	ND
	1997	1	ND	ND	ND	ND	NS
		2	ND	13.5	ND	89	63
		3	ND	4.1	ND	30.7	NS
		4	NS	NS	NS	NS	NS
	1998	1	ND	0.33	ND	1.5	NS
		1 duplicate	ND	0.39	ND	0.94	NS
		2	ND	ND	ND	ND	5.3
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	1.9

Table 1
Groundwater Monitoring Data
L. E. Carpenter - Wharton, New Jersey

MONITORING WELLS	SAMPLING DATE		CHEMICAL ANALYSIS RESULTS				
	YEAR	QUARTER	Benzene µg/L	Ethylbenzene µg/L	Toluene µg/L	Total Xylenes µg/L	bis-2- Ethylhexylphthalate (DEHP) µg/L
NJDEP GWQS			1	700	1,000	40	30
ROD DISCHARGE CRITERIA			1	350	500	20	30
MW-25 (continued)	1999	1	ND	ND	ND	ND	ND
		2	ND	ND	ND	14	ND
		3	ND	0.39	ND	1.4	9.6
		4	ND	ND	ND	ND	ND
	2000	1	ND	ND	ND	ND	ND
		2	ND	ND	ND	ND	ND
MW-30	1995	1	NS	NS	NS	NS	NS
		2	ND	17	ND	13	45,000
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	ND
	1996	1	ND	ND	ND	ND	NS
		2	NS	NS	NS	NS	NS
		3	ND	ND	ND	ND	NS
		4	NS	NS	NS	NS	NS
	1997	1	NS	NS	NS	NS	NS
		2	ND	ND	ND	ND	2.2
MW-30S	1997	1	ND	0.2	ND	1.0	NS
		2	NS	NS	NS	NS	NS
		3	ND	4.1	ND	30.7	NS
		4	NS	NS	NS	NS	NS
Trip Blank	1995	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	NS
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	NS
	1996	1	ND	ND	ND	ND	NS
		2	NS	NS	NS	NS	NS
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	NS
	1997	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	ND
		3	ND	ND	ND	ND	NS
		4	NS	NS	NS	NS	NS
	1998	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	ND
	1998	3	ND	ND	ND	ND	NS
		4	ND	ND	ND	NS	1.3
	1999	1	ND	ND	ND	NS	ND
		2	ND	ND	ND	NS	ND
		3	ND	ND	ND	ND	ND
		4	ND	ND	ND	ND	NS

Table 1
Groundwater Monitoring Data
L. E. Carpenter - Wharton, New Jersey

MONITORING WELLS	SAMPLING DATE		CHEMICAL ANALYSIS RESULTS				
	YEAR	QUARTER	Benzene µg/L	Ethylbenzene µg/L	Toluene µg/L	Total Xylenes µg/L	bis-2-Ethylhexylphthalate (DEHP) µg/L
NJDEP GWQS			**1**	**700**	**1,000**	**40**	**30**
ROD DISCHARGE CRITERIA			**1**	**350**	**500**	**20**	**30**
Trip Blank (continued)	2000	1	NS	NS	NS	NS	ND
		1	NS	NS	NS	NS	ND
		2	ND	ND	ND	ND	NS
Field Blank	1995	1	ND	ND	ND	ND	ND
		2	ND	0.73	ND	ND	1.3
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	ND
	1996	1	ND	ND	ND	ND	NS
		2	NS	NS	NS	NS	NS
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	ND
	1997	1	ND	ND	0.2	ND	NS
		2	ND	ND	ND	ND	NS
		3	ND	ND	ND	ND	NS
		4	NS	NS	NS	NS	NS
	1998	1	ND	ND	ND	ND	NS
		2	ND	ND	ND	ND	NS
		3	ND	ND	ND	ND	NS
		4	ND	ND	ND	ND	1.3
	1999	1	ND	ND	ND	ND	ND
		2	ND	ND	ND	ND	ND
		3	ND	ND	ND	ND	ND
		4	ND	ND	ND	ND	ND
	2000	1	ND	ND	ND	ND	ND
		1	ND	ND	ND	ND	NS
		1	NS	NS	NS	NS	3.2
		2	ND	ND	ND	ND	ND

Notes:

Values in BOLD BLUE FONT are above BOTH the NJDEP GWQS and the ROD Discharge Criteria.

-- Used when comparison against known standards does not apply as the well was not sampled (NS) for a specific analyte

mg/L = micrograms per liter.

NJGWQS = New Jersey Groundwater Quality Standards.

ROD = Record of Decision.

NA = not applicable.

NS = not sampled.

ND = no detection.

duplicate = duplicate sample.

J = estimated value.

D = secondary dilution.

B = detected in blank.

Table 2
Preferred Reactions by Energy Potential

ELECTRON ACCEPTOR	TYPE OF REACTION	METABOLIC BY-PRODUCT	REACTION PREFERENCE
Oxygen	Aerobic	CO_2	Most preferred
Nitrate	Anaerobic	N_2, CO_2	↓
Ferric Iron (solid)	Anaerobic	Ferrous iron (dissolved)	↓
Sulfate	Anaerobic	H_2S	↓
Carbon dioxide	Anaerobic	Methane	Least preferred

From Newell et al., 1996

Table 3
Natural Attenuation Indicator Parameter Concentrations

SAMPLE LOCATION	DATE	DISSOLVED OXYGEN (mg/L)	REDOX POTENTIAL (at sample) (mV)	NITRATE (mg/L)	FERROUS IRON (mg/L)	SULFATE (mg/L)	CO_2 (at sampling) (mg/L)	HETEROTROPHIC PLATE COUNT (colonies/1 mL)
MW-15S	1-Dec-98	0.10	9.31	0.14	0.56	5.3	40	400
	22-Jan-99	4.25	-8.00	-	-		30	
	16-Apr-99	3.70	7.00	ND	ND		25	
	22-Jul-99	0.98	50.5	0.18	1.50		30	
WP-A3	1-Dec-98	1.70	152.5	0.57	ND	13.5	36	600
	22-Jan-99	3.40	191.3	1.00	ND		35	
	16-Apr-99	8.80	185.0	0.60	ND		22	
	23-Jul-99	0.98	220.4	0.38	ND		40	
MW-17S	1-Dec-98	4.70	146.1	0.15	ND	15.1	24	35
	22-Jan-99	5.80	210.7	0.17	ND		12	
	16-Apr-99	6.30	166.9	ND	ND		20	
	22-Jul-99	1.23	97.5	ND	ND		46	
WP-C4[1]	1-Dec-98	0.00	-144.1	ND	7.60	ND	85	17,100
	22-Jan-99	0.00	-61.2	0.52	0.25		40	
	16-Apr-99	0.42	-39.2	ND	0.79		65	
WP-B10	1-Dec-98	0.00	-134.7	ND	32.40	7.6	225	19,000
	22-Jan-99	0.00	-180.6	ND	22.10		295	
	16-Apr-99	0.11	-196.5	ND	20.80		115	
	23-Jul-99	0.35	-209.6	ND	42.70		360	
MW-2R	1-Dec-98	0.20	-168.1	ND	35.40	ND	170	9,000
	22-Jan-99	0.00	-202.5	ND	19.00		105	
	16-Apr-99	0.07	-164.3	ND	37.20		170	
	23-Jul-99	0.11	-167.8	ND	44.70		210	
	13-Apr-00	0.00	-143.0	< 0.1	2.60	< 5.0		2,000
WP-B6	1-Dec-98	0.00	-118.4	ND	59.80	ND	370	1,100
	22-Jan-99	0.00	-163.1	ND	37.90		180	
	16-Apr-99	0.11	-170.1	ND	36.70		180	
	23-Jul-99	0.18	-165.2	ND	60.20		320	

Table 3
Natural Attenuation Indicator Parameter Concentrations

SAMPLE LOCATION	DATE	DISSOLVED OXYGEN (mg/L)	REDOX POTENTIAL (at sample) (mV)	NITRATE (mg/L)	FERROUS IRON (mg/L)	SULFATE (mg/L)	CO_2 (at sampling) (mg/L)	HETEROTROPHIC PLATE COUNT (colonies/1 mL)
WP-C1[1]	22-Jul-99	1.59	-147.9	ND	13.80		165	
MW-6R	1-Dec-98	0.00						
	22-Jan-99	0.00						
	16-Apr-99	0.07						
	23-Jul-99	0.04						
	13-Apr-00	0.00	-187.0	< 0.1	2.80	< 5.0		2,300
MW-22R	22-Jul-99	0.90						
	13-Apr-00	0.20	-137.0	< 0.1	2.40	< 5.0		340
MW-25R	22-Jul-99	1.00						
	13-Apr-00	0.50	-71.0	< 0.1	1.80	< 5.0		600

Note:

[1] During third quarter 1999 sampling event WP-C4 was found to be destroyed. WP-C1 will replace this well from this point forward.

Table 4
Bioscreen Model Input Parameters

	Longitudinal Dispersivity (feet)	Retardation Coefficient	1st Order Decay Coefficient (per year)	Source Mass (kg)	Source Concentration (mg/L)
Parameter Set 1					
Xylenes (Run 5j)	14	3.4	1.2	Infinite	120
Ethylbenzene (Run 6c)	14	4.0	0.8	Infinite	16
DEHP (Run 7c)	14	9	0.3	Infinite	62
Parameter Set 2					
Xylenes (Run 5i)	14	3.4	1.2	70,000	127
Ethylbenzene (Run 6b)	14	4.0	0.8	10,000	17
DEHP (Run 7d)	14	9	0.3	100,000	63

NOTE:

MAP OBTAINED FROM UNITED STATES GEOLOGICAL SURVEY DOVER, NEW JERSEY 7.5 MINUTE SERIES QUADRANGLE (TOPOGRAPHIC), 1981.

N

0 2000 4000

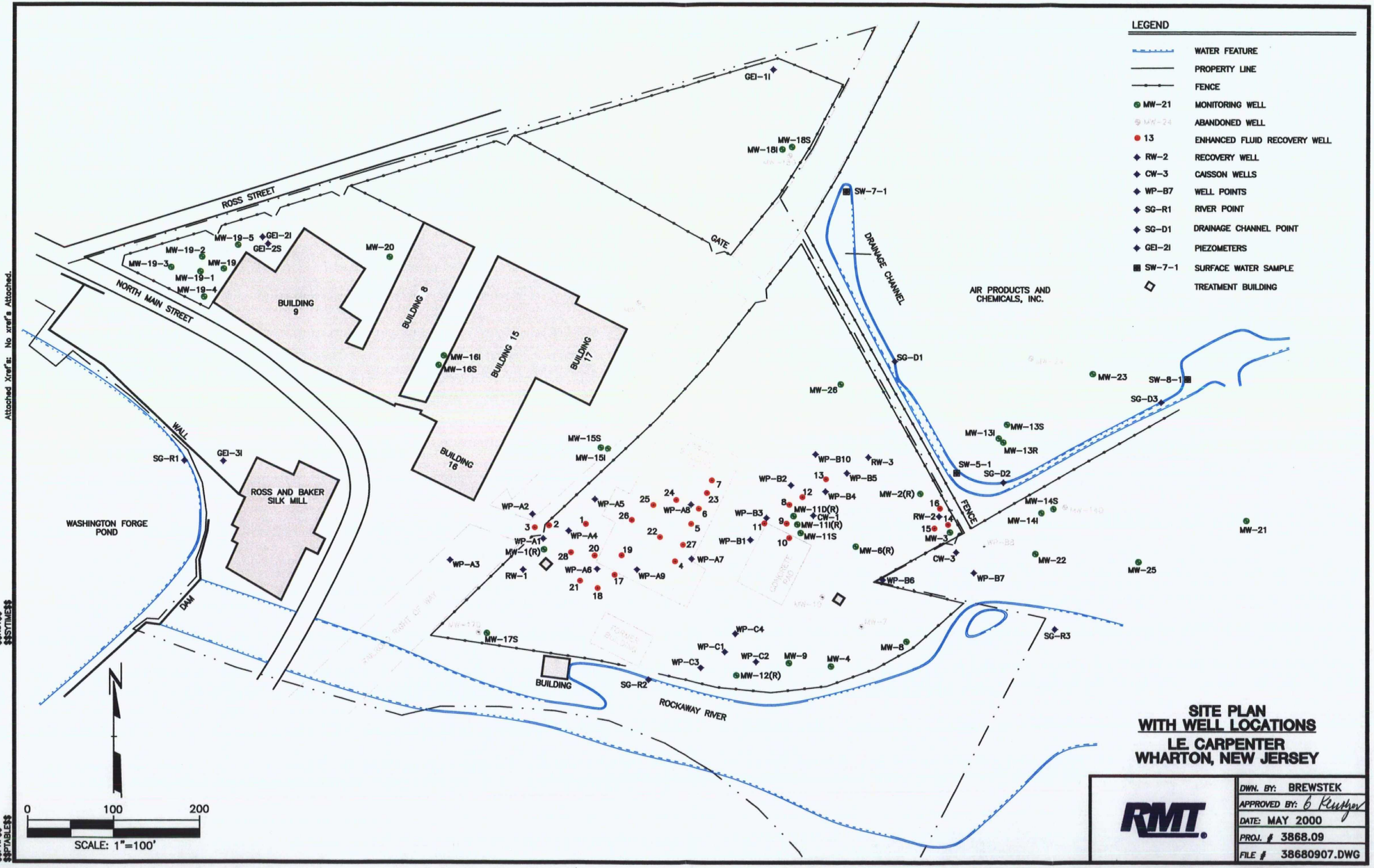
SCALE: 1"=2000'

SITE LOCATION MAP
L.E. CARPENTER AND COMPANY
WHARTON, NEW JERSEY

RMT®

DWN. BY:	DAY
APPROVED BY:	G. Kenoyer
DATE:	5/2/00
PROJ. #	3863.17
FILE #	38681704

FIGURE 1

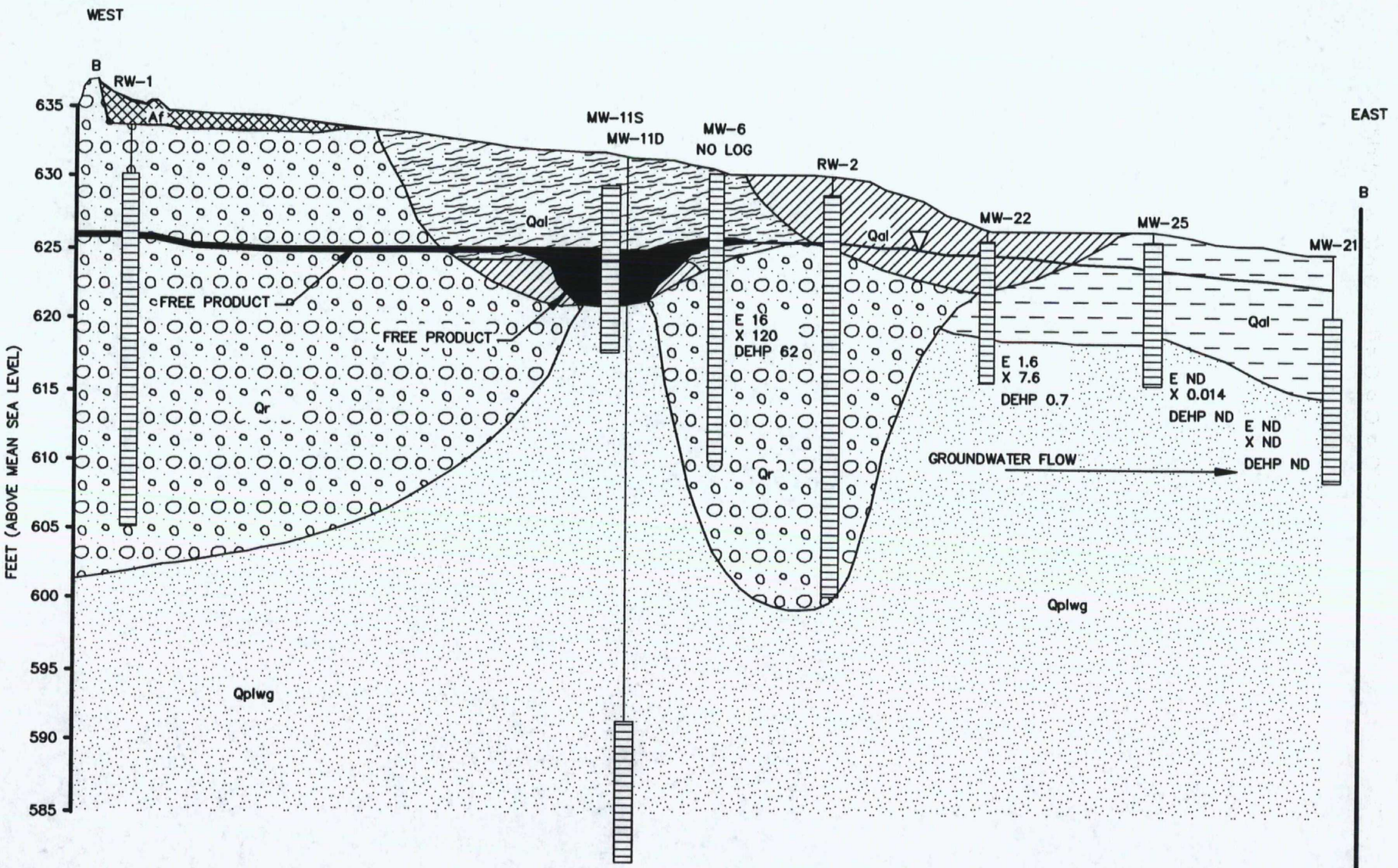


SITE PLAN
WITH WELL LOCATIONS
LE. CARPENTER
WHARTON, NEW JERSEY

RMT

DWN. BY:	BREWSTEK
APPROVED BY:	G Kreutzer
DATE:	MAY 2000
PROJ. #	3868.09
FILE #	38680907.DWG

FIGURE 2



LEGEND

- FREE PRODUCT LAYER
- E= ETHYLBENZENE (mg/L)
- X= XYLENE (mg/L)
- DEHP= DIETHYL HEXYL PTHALATE (mg/L)
- WATER TABLE
- MW-21 WELL NUMBER
- CASED INTERVAL
- SCREENED INTERVAL
- BACKFILLED INTERVAL
- Af — FILL: BROWN, COARSE TO FINE , SOME SILT, LITTLE GRAVEL, SOME ORGANIC MATERIAL
- Qal — CLAY: ALLUVIUM–GREY CLAY, SOME SILT, TRACE FINE SAND, SOME ROUNDED PEBBLES
- Qal — SILT: ALLUVIUM–DARK GREY SILT, SOME CLAY TRACE FINE TO COARSE SAND, SOME FINE TO MEDIUM GRAVEL, FREQUENT BOULDERS
- Qal — SAND: ALLUVIUM–GREY/BROWN, MEDIUM GRAINED SAND, LITTLE SILT, TRACE CLAY
- Qal — SAND: SILTY SAND WITH GRAVEL AND BOULDERS, SOME CLAY.
- Qr — GRAVEL: ROCKAWAY RIVER OUTWASH–GREY COARSE TO FINE GRAVEL, LITTLE COARSE TO FINE SAND, ABUNDANT COBBLES AND BOULDERS
- Qplwg — SAND: STRATIFIED DEPOSITS–GREY/BROWN COARSE TO FINE SAND, LITTLE GRAVEL, TRACE SILT, OCCASIONAL COBBLES AND BOULDERS.

WATER LEVELS FROM 2ND QUARTER 1999 (RMT, 1999)

CHEMISTRY FROM 2ND QUARTER 1999, EXCEPT MW–6 FROM JAN. 1990 (RMT, 1999; WESTON, 1992)

0 50' 100'
SCALE: 1"=50'

CONCEPTUAL HYDROGEOLOGIC CROSS SECTION

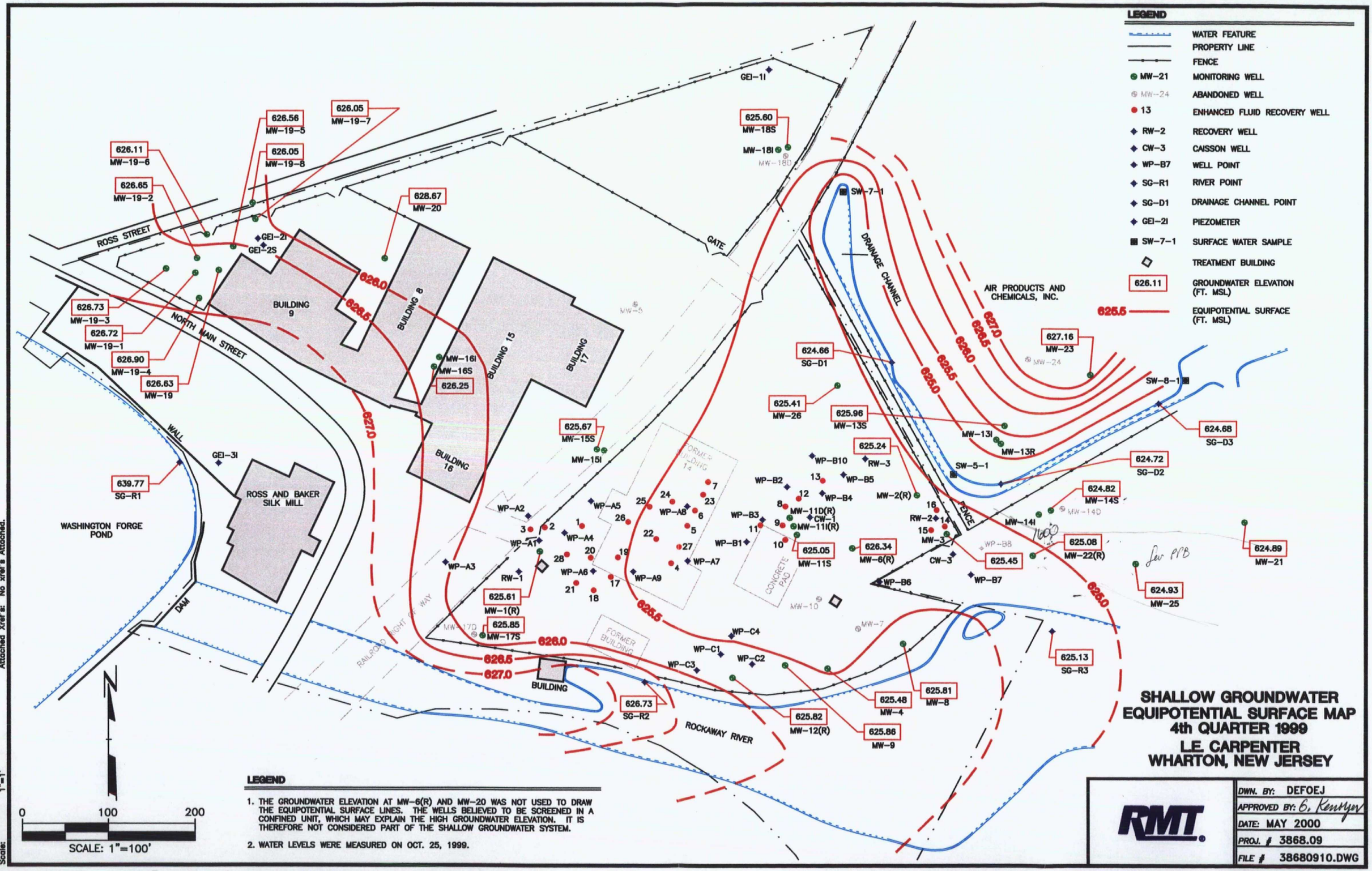
L.E. CARPENTER AND CO. WHARTON, NJ

(MODIFIED FROM FIG. 3–6 IN WESTON, 1992)

RMT

DWN. BY:	DEFOEJ
APPROVED BY:	G. Kemper
DATE:	MAY 2000
PROJ. #	3868.09
FILE #	38680909.DWG

FIGURE 3



LEGEND

1. THE GROUNDWATER ELEVATION AT MW-6(R) AND MW-20 WAS NOT USED TO DRAW THE EQUIPOTENTIAL SURFACE LINES. THE WELLS BELIEVED TO BE SCREENED IN A CONFINED UNIT, WHICH MAY EXPLAIN THE HIGH GROUNDWATER ELEVATION. IT IS THEREFORE NOT CONSIDERED PART OF THE SHALLOW GROUNDWATER SYSTEM.
2. WATER LEVELS WERE MEASURED ON OCT. 25, 1999.

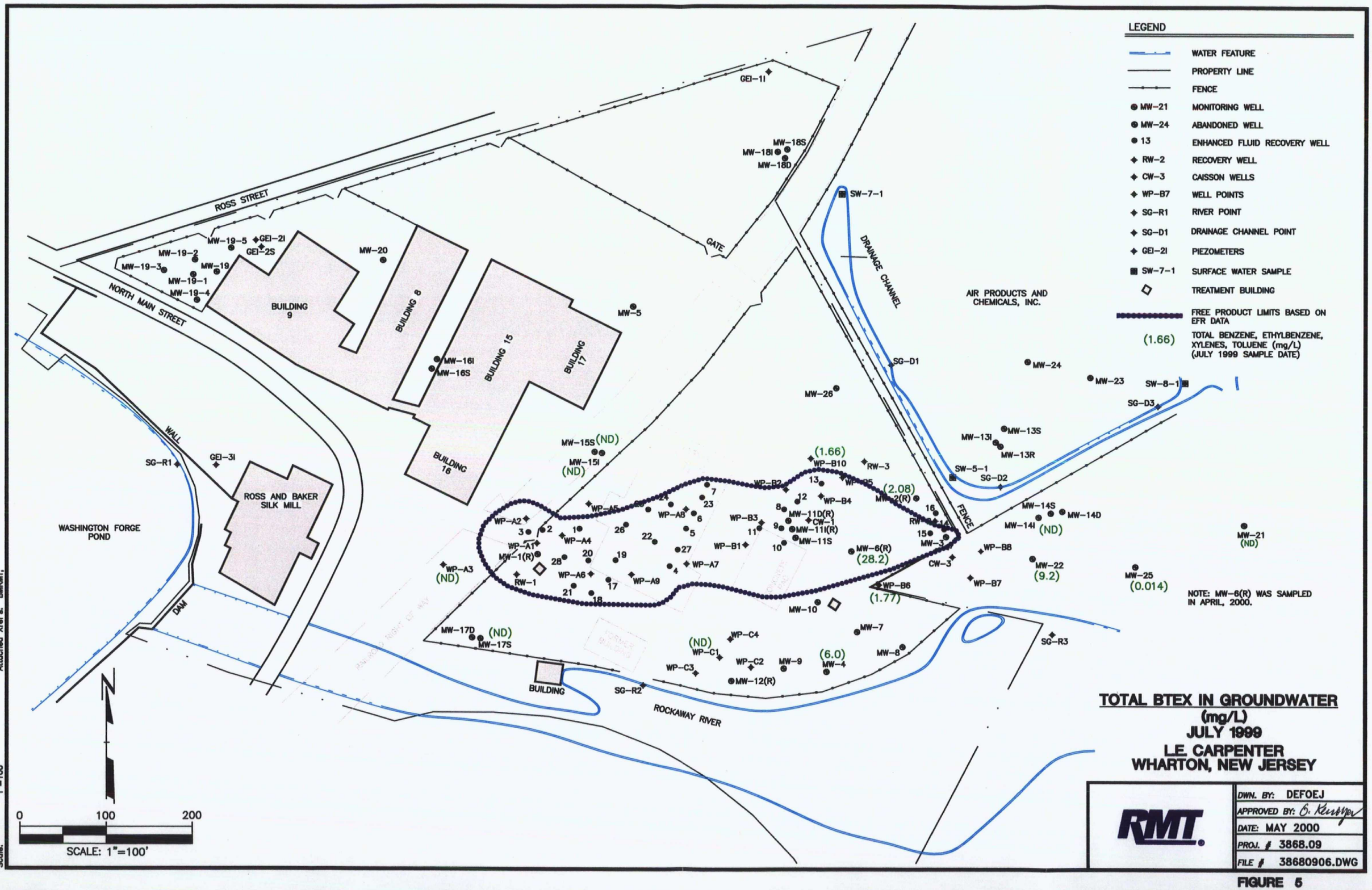
SHALLOW GROUNDWATER EQUIPOTENTIAL SURFACE MAP 4th QUARTER 1999 LE CARPENTER WHARTON, NEW JERSEY

RMT

DWN. BY:	DEFOEJ
APPROVED BY:	G. Kentzer
DATE:	MAY 2000
PROJ. #	3868.09
FILE #	38680910.DWG

FIGURE 4

PLOT DATA
Drawing Name: J:\03868\09\38680910.dwg
Operator Name: DEFOEJ
Scale: 1"=1'
Dwg Size:
Plot Date: 240220 Bytes
Plot Time: Tuesday, February 29, 2000 08:05:5311 AM
Attached Xref's: No xref's Attached.



PLOT DATE
Drawing Name: J:\03868\09\38680906.dwg
Operator Name: DEFOEJ
Scale: 1"=100'
Dwg Size:
Plot Date:
Plot Time: 208452 Bytes Tuesday, February 29, 2000 10:44:33 09 AM
Attached Xref's: BMRMT;

FIGURE 5

Attached Xref's: No xref's Attached.

$$DWG$$ $$USER$$ $$PRF$$ $$PTABLE$$ $$SCALE$$ $$ROT$$ $$XYTIME$$

LEGEND

- FREE PRODUCT LIMITS BASED ON EFR DATA
- WATER FEATURE
- PROPERTY LINE
- FENCE
- MW-21 MONITORING WELL
- MW-24 ABANDONED WELL
- 13 ENHANCED FLUID RECOVERY WELL
- RW-2 RECOVERY WELL
- CW-3 CAISSON WELLS
- WP-B7 WELL POINTS
- SG-R1 RIVER POINT
- SG-D1 DRAINAGE CHANNEL POINT
- GEI-2I PIEZOMETERS
- SW-7-1 SURFACE WATER SAMPLE
- TREATMENT BUILDING
- (0.005) CONCENTRATION OF DIETHYL HEXYL PHTALATE (DEHP) IN mg/L

ROSS STREET
NORTH MAIN STREET
WALL
DAM
WASHINGTON FORGE POND
ROSS AND BAKER SILK MILL
BUILDING 9
BUILDING 8
BUILDING 15
BUILDING 17
BUILDING 16
BUILDING
GATE
DRAINAGE CHANNEL
FENCE
AIR PRODUCTS AND CHEMICALS, INC.
ROCKAWAY RIVER
PROPERTY LINE

GEI-1I
MW-18S
MW-18I
SW-7-1
MW-19-5
GEI-2I
GEI-2S
MW-19-2
MW-19-3
MW-19
MW-19-1
MW-19-4
MW-20
MW-16I
MW-16S
SG-R1
GEI-3I
MW-15S (ND)
MW-15I (0.005)
MW-17S (ND)
MW-26
SG-D1
MW-23
SW-8-1
SG-D3
MW-13I
MW-13S
MW-13R
SW-5-1
SG-D2
MW-14S
MW-14I (ND)
MW-21 (ND)
MW-22 (0.67)
MW-25 (0.01)
SG-R3
MW-8
MW-4 (3.0)
MW-9
MW-12(R)
WP-C1 (0.016)
WP-C4 (0.2)
WP-C2
WP-C3
SG-R2
MW-1(R)
MW-1
WP-A3 (ND)
WP-A1
WP-A2
WP-A4
WP-A5
WP-A6
WP-A7
WP-A8
WP-A9
WP-B1
WP-B2
WP-B3
WP-B4
WP-B5
WP-B6 (39)
WP-B7
WP-B10 (2.2)
MW-2(R) (16.0)
MW-11D(R) (59)
MW-11I(R)
MW-11S
MW-6(R) (80)
RW-3
CW-1
CW-3
MW-3

NOTE: MW-4, MW-14I, MW-15I, AND MW-22 WERE SAMPLED IN APRIL 1999.
MW-6(R) WAS SAMPLED IN APRIL 2000.

0 100 200
SCALE: 1"=100'

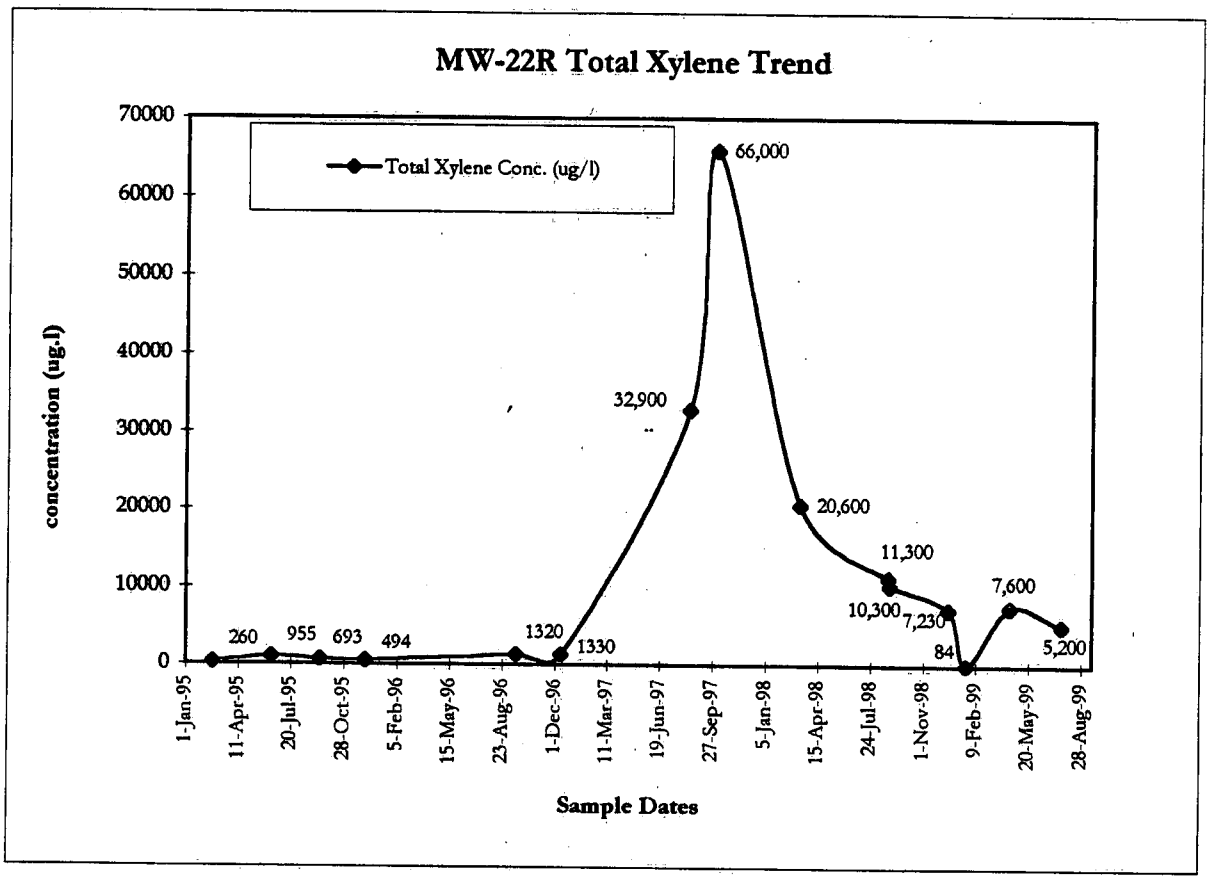
DEHP IN GROUNDWATER (mg/L) JULY 1999

LE CARPENTER WHARTON, NEW JERSEY

RMT

DWN. BY:	DEFOEJ
APPROVED BY:	G. Kenyon
DATE:	MAY 2000
PROJ. #	3868.09
FILE #	38680908.DWG

FIGURE 6



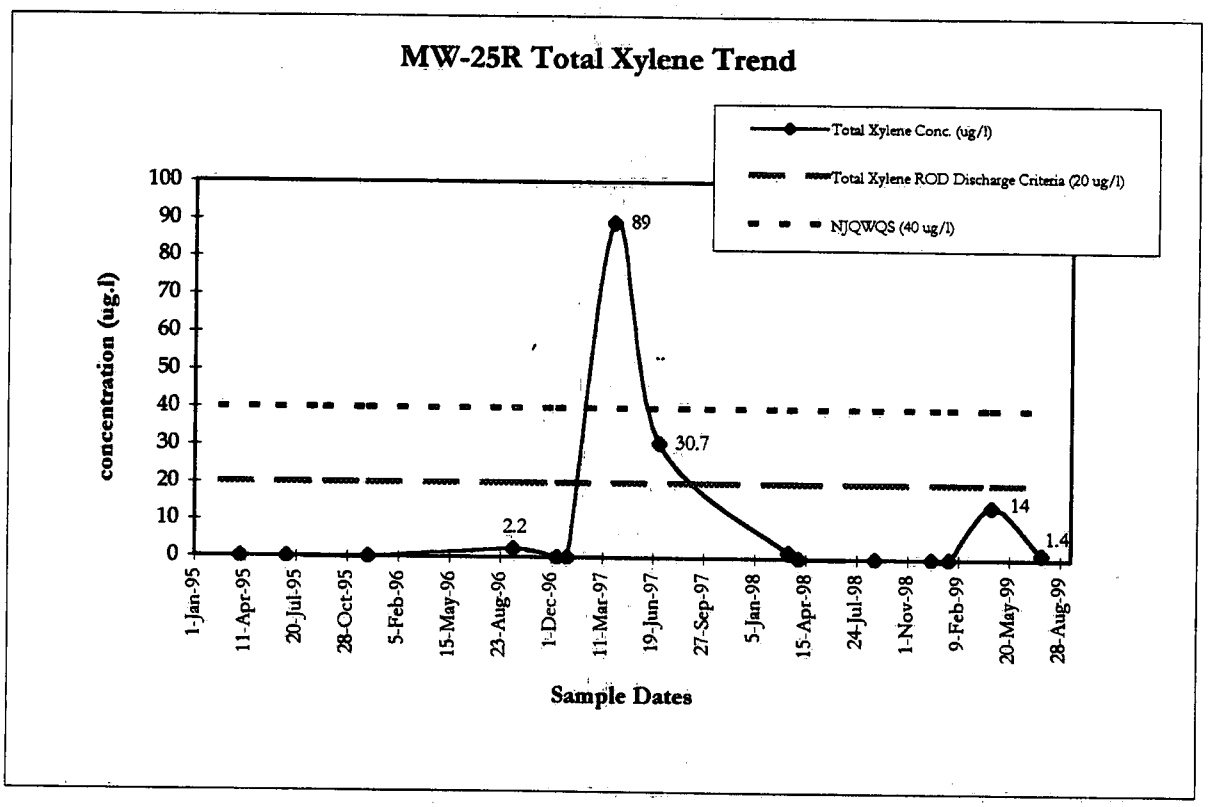
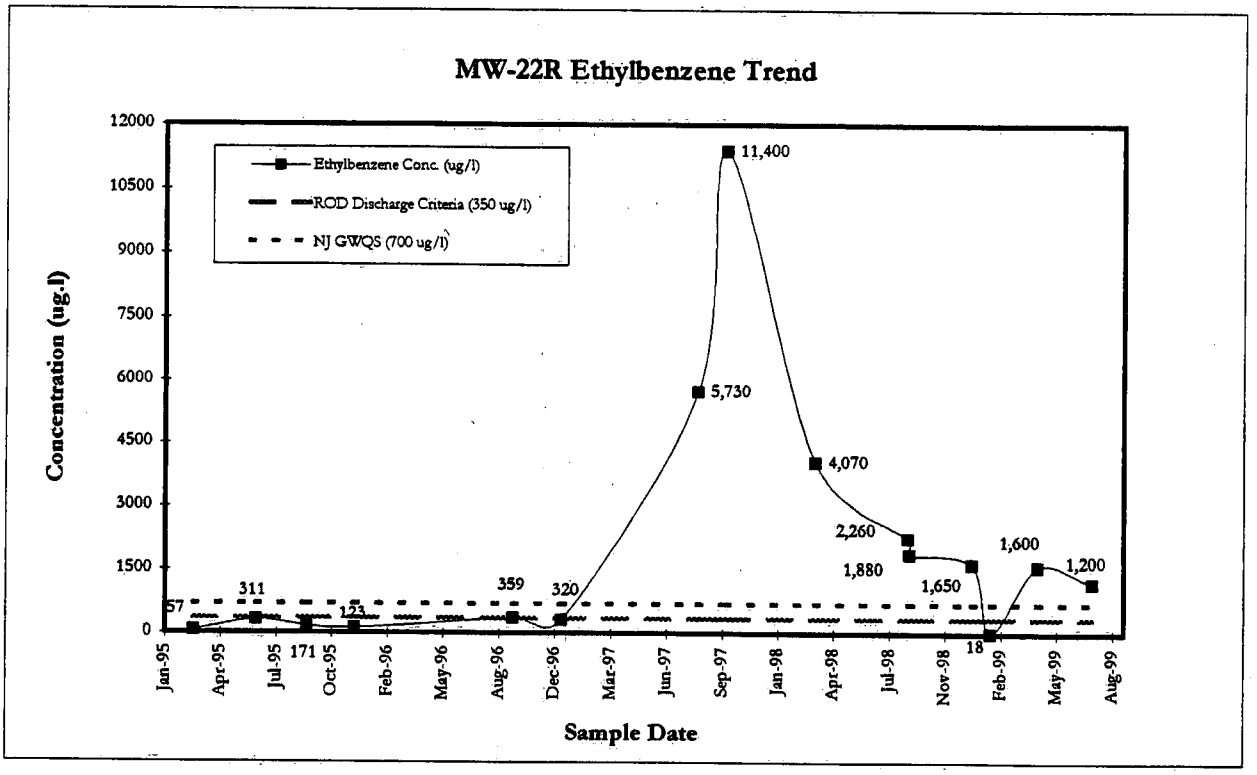


Figure 7a
Concentration of Xylenes in Downgradient Wells Over Time



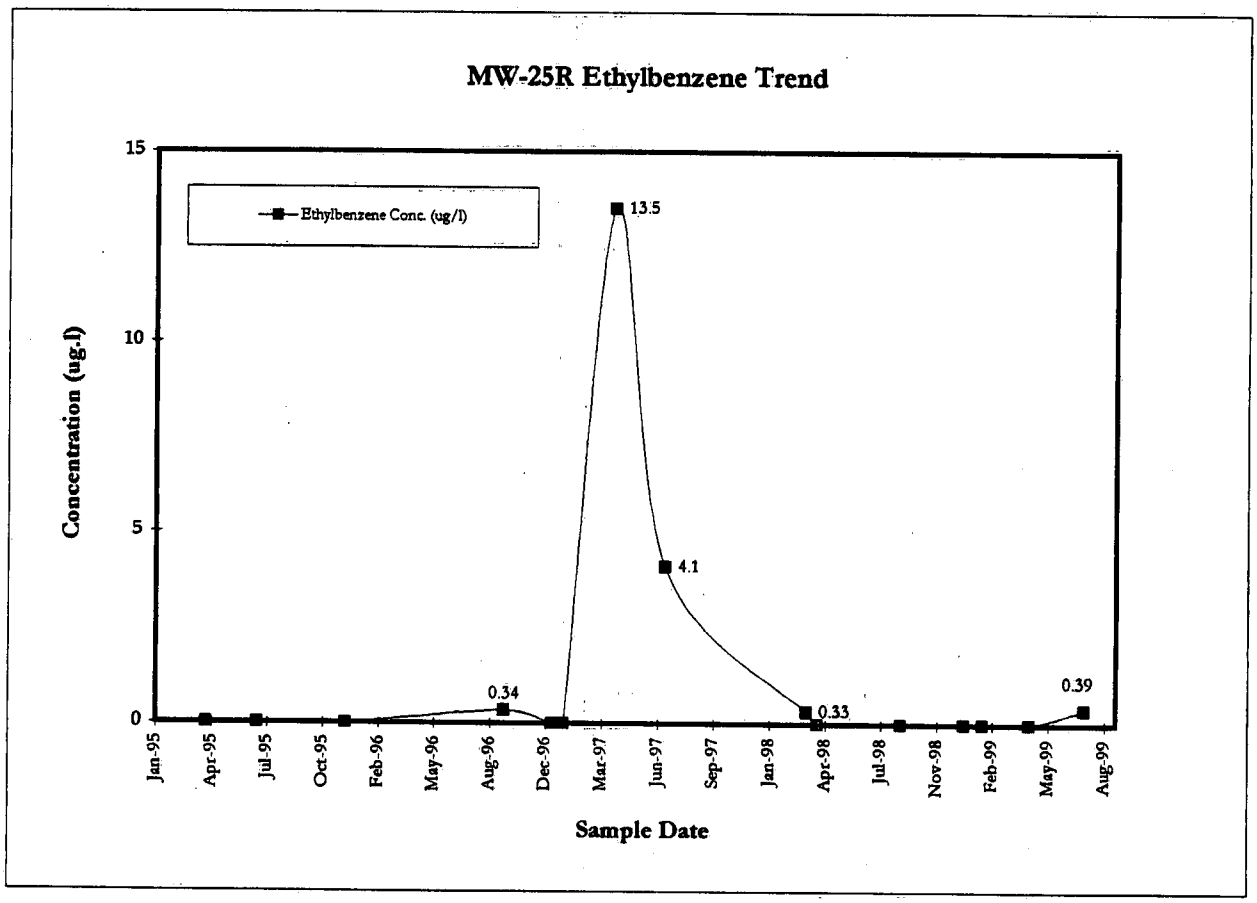
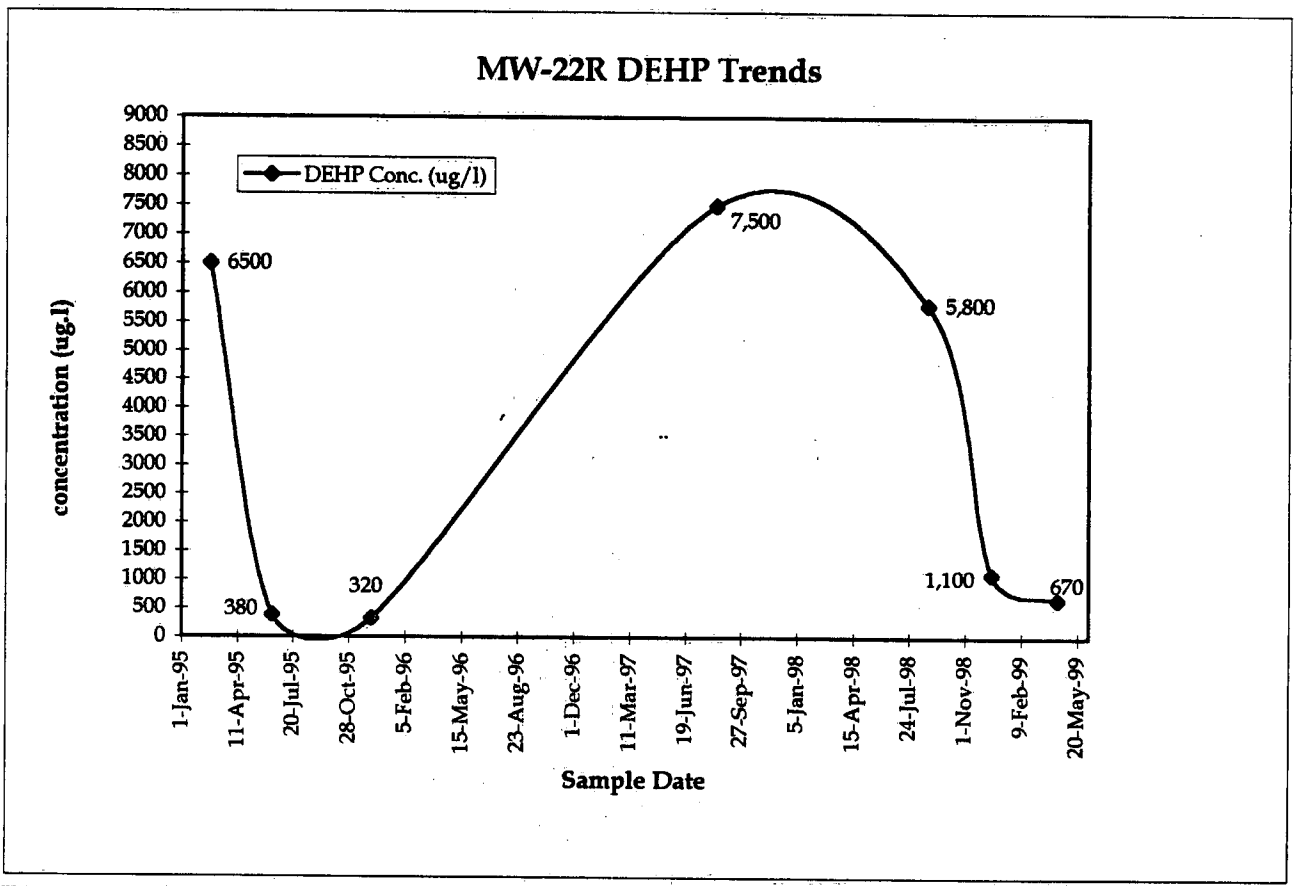


Figure 7b
Concentration of Ethylbenzene in Downgradient Wells Over Time



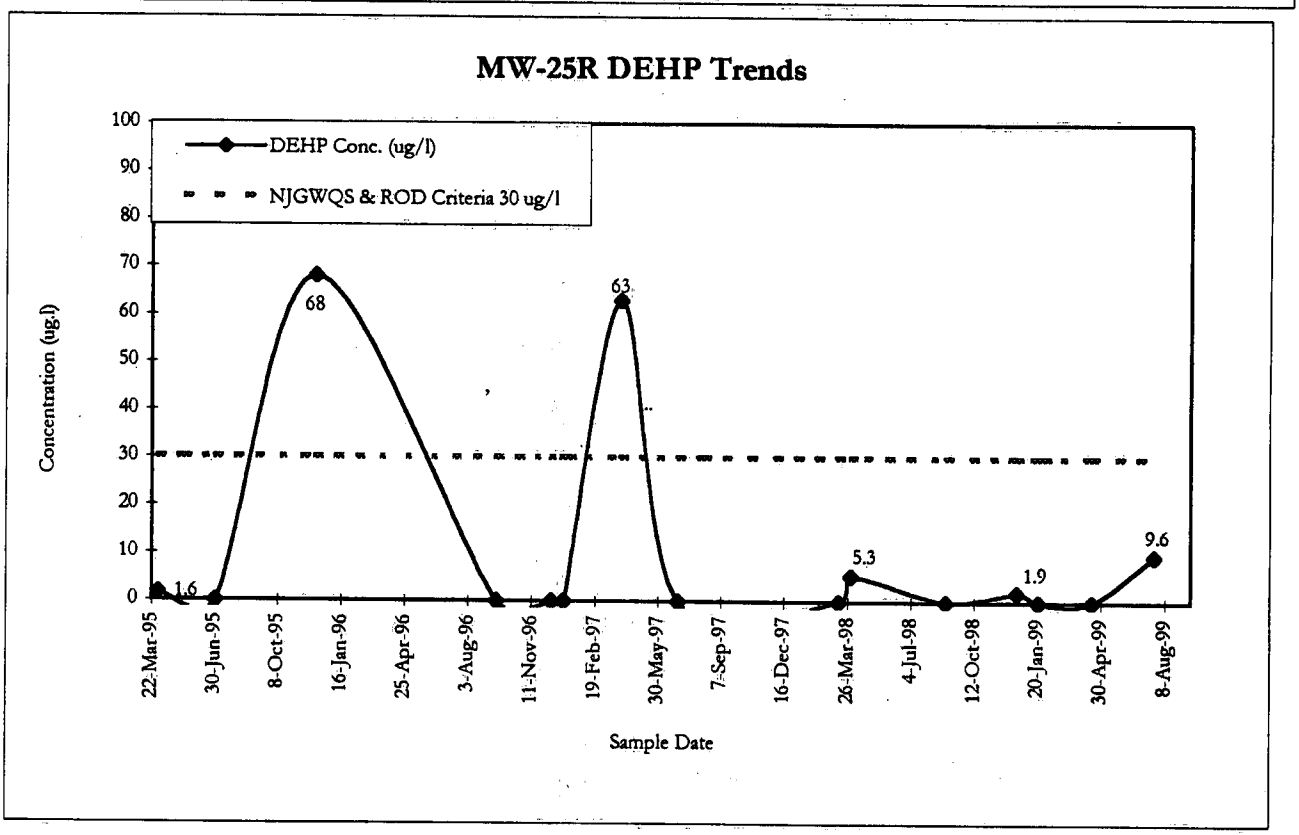
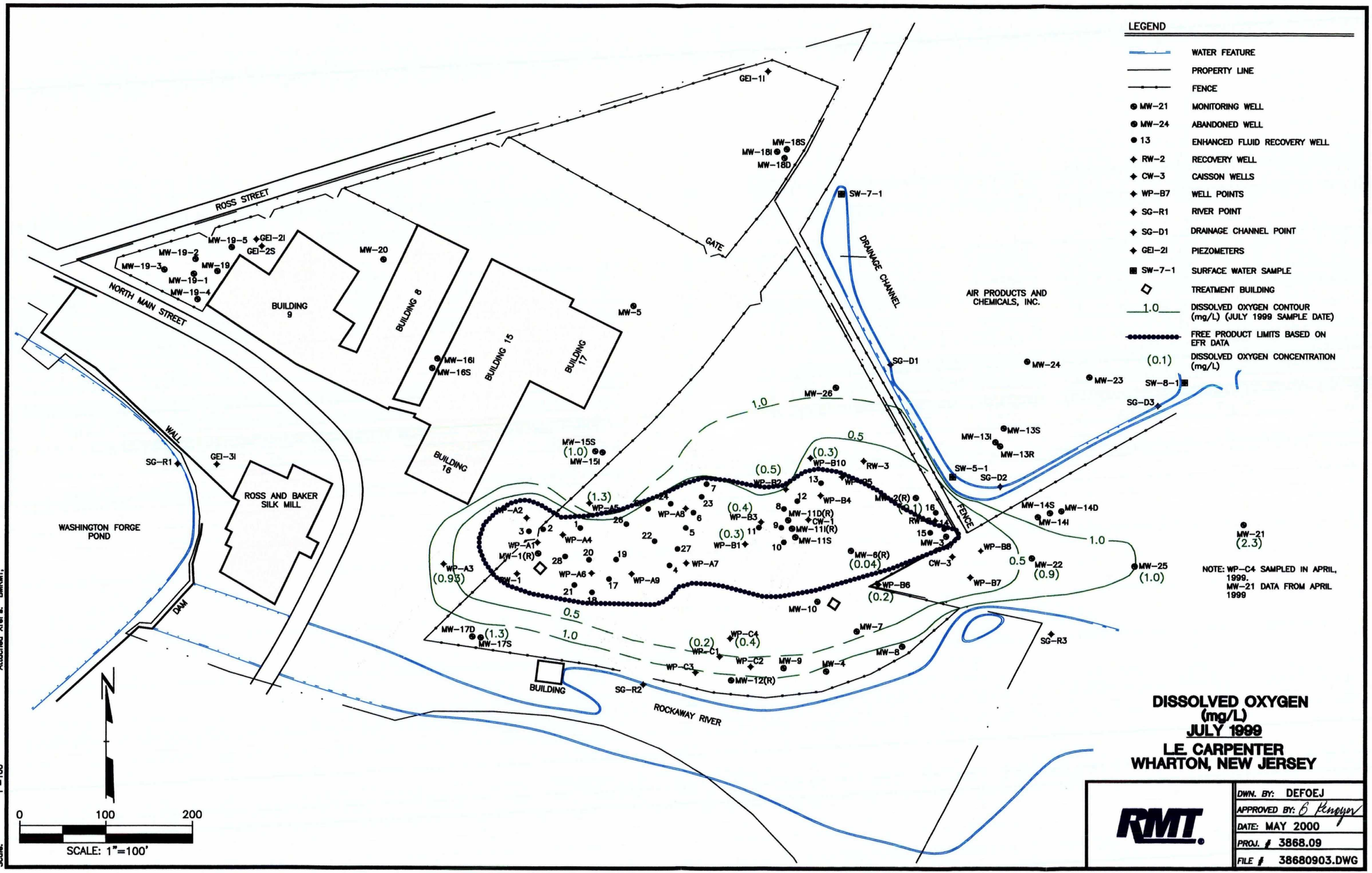
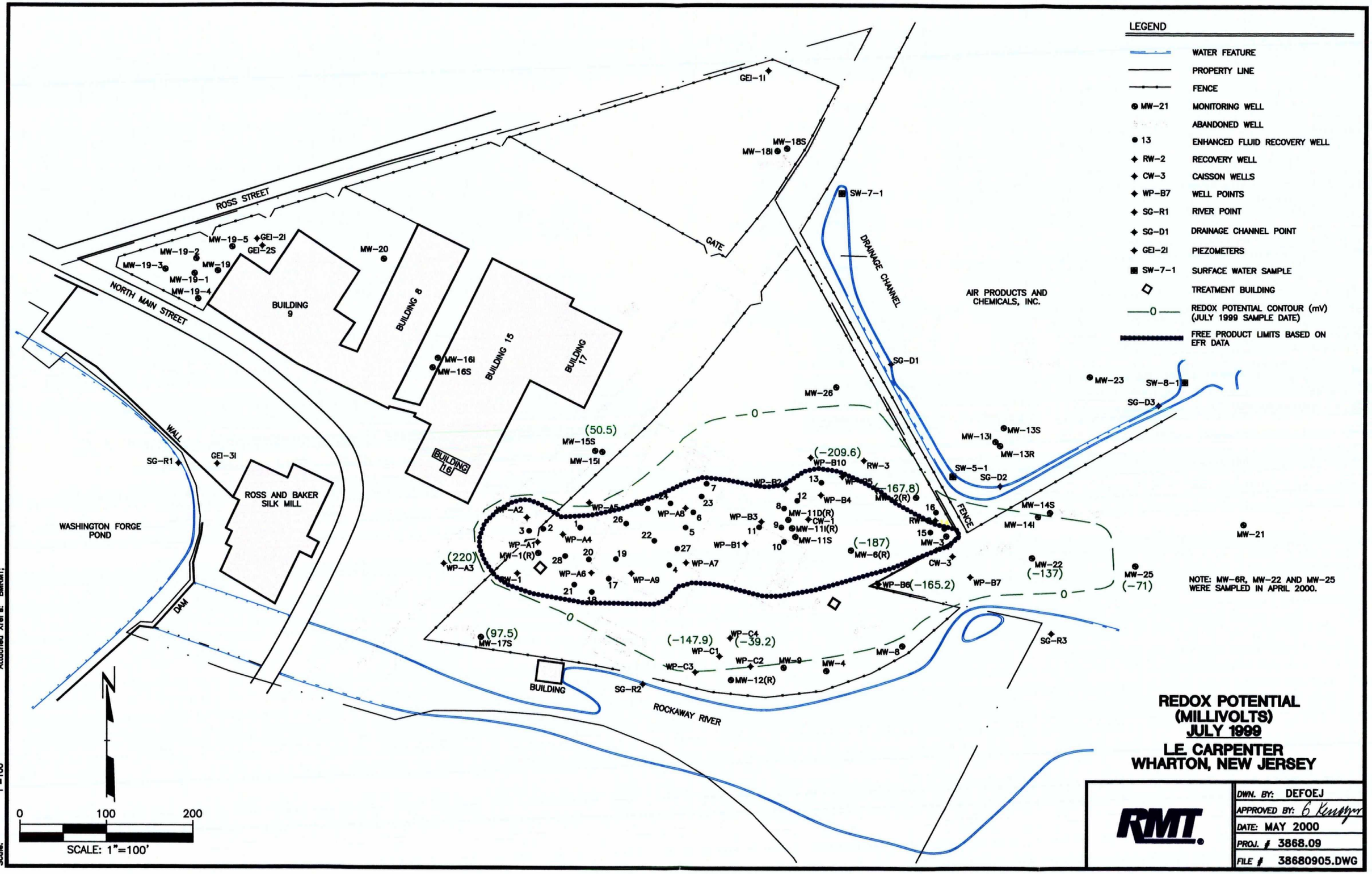


Figure 7c
Concentration of DEHP in Downgradient Wells Over Time



PLOT DATA
Drawing Name: J:\03868\09\38680903.dwg
Operator Name: DEFOEJ
Scale: 1"=100'
Dwg Size:
Plot Date: 247385 Bytes
Plot Time: Thursday, May 11, 2000 10:22:45 AM
Attached Xref's: BMRMT;

FIGURE 8



REDOX POTENTIAL (MILLIVOLTS) JULY 1999

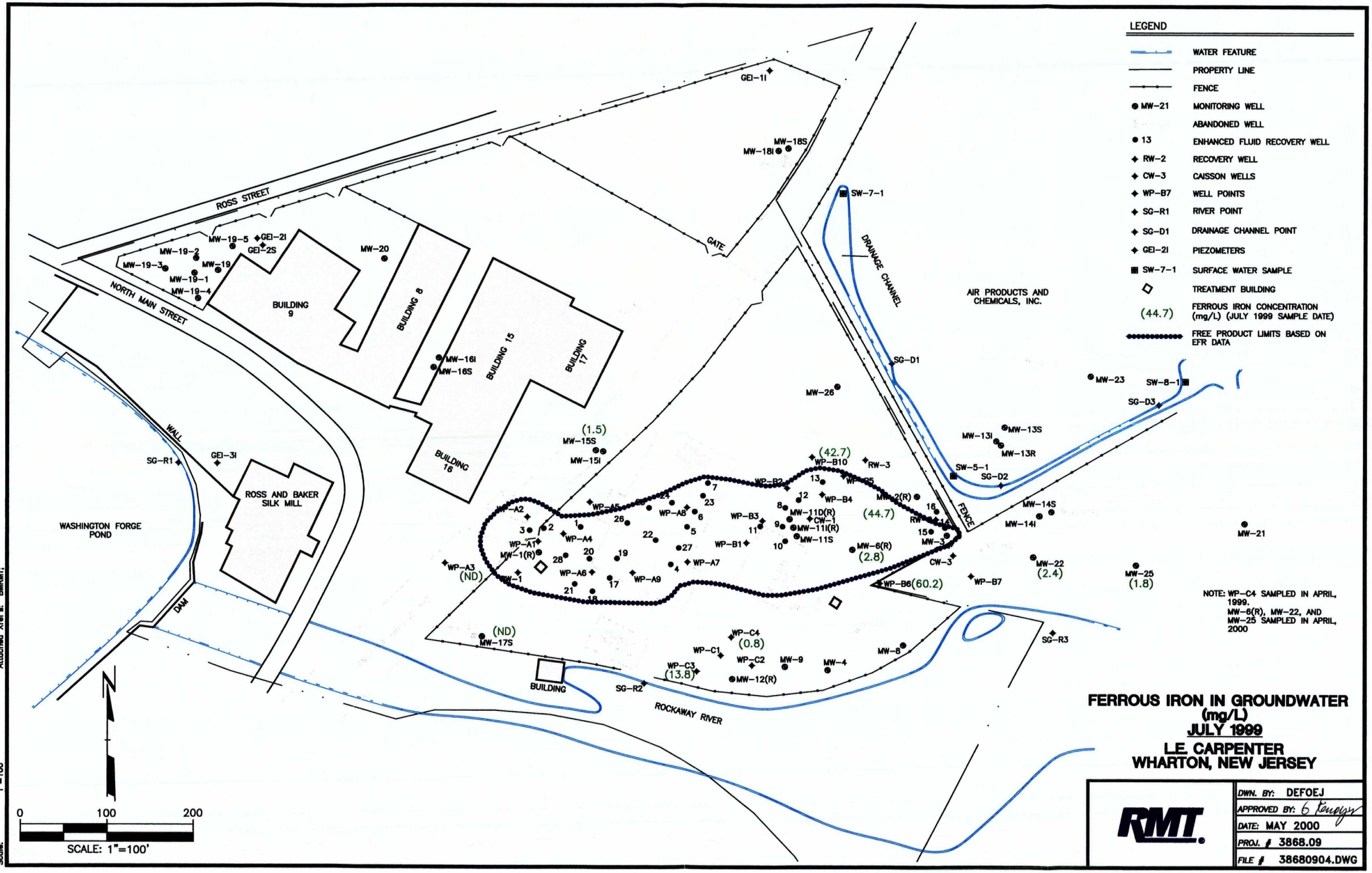
LE CARPENTER WHARTON, NEW JERSEY

DWN. BY:	DEFOEJ
APPROVED BY:	G Kenyon
DATE:	MAY 2000
PROJ. #	3868.09
FILE #	38680905.DWG

RMT

FIGURE 9

PLOT DATE
Drawing Name: J:\03868\09\38680905.dwg
Operator Name: DEFOEJ
Scale: 1"=100'
Dwg Size:
Plot Date:
Plot Time:
Attached Xref's: BMRMT;
227618 Bytes
Thursday, May 11, 2000
10:13:5446 AM



Drawing Name: J:\03868\09\38680904.dwg
Operator Name: DEFOEJ
Scale: 1"=100'
Dwg Size: 22/12x Bytes
Plot Date: Thursday, May 11, 2000
Plot Time: 10:20:48 AM
Attached Xref's: BMRMT;

FIGURE 10

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 5J
Xylenes, MW6/MW22
Run Name

Data Input Instructions:

115 ↑ or 0.02

1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

Variable*	*Data used directly in model.*
20	*Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	73.0	*(ft/yr)*
or		↑ or	
Hydraulic Conductivity	*K*	1.1E-02	*(cm/sec)*
Hydraulic Gradient	*i*	0.003	*(ft/ft)*
Porosity	*n*	0.3	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	14.0	*(ft)*
Transverse Dispersivity*	*alpha y*	1.5	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		↑ or	
Estimated Plume Length	*Lp*	320	*(ft)*

3. ADSORPTION

Retardation Factor*	*R*	3.4	*(-)*
or		↑ or	
Soil Bulk Density	*rho*		*(kg/l)*
Partition Coefficient	*Koc*		*(L/kg)*
FractionOrganicCarbon	*foc*		*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	1.2E+0	*(per yr)*
or		↑ or	
Solute Half-Life	*t-half*		*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	800	*(ft)*	L →
Modeled Area Width*	250	*(ft)*	W ↕
Simulation Time*	30	*(yr)*	

6. SOURCE DATA

Source Thickness in Sat.Zone* 10 *(ft)*

Source Zones:

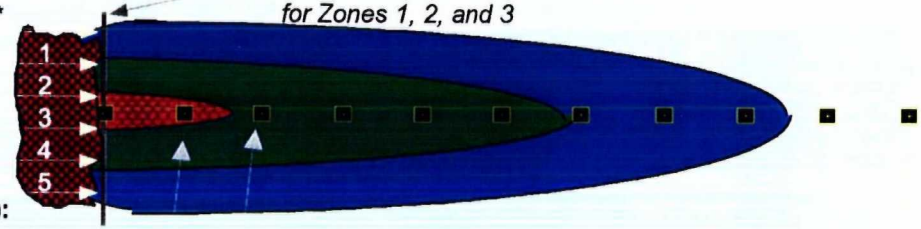
Width* (ft)	Conc. (mg/L)*
50	1
50	12
150	120
50	12
50	1

Source Halflife (see Help):

		(yr)
Inst. React. ↑	↑ 1st Order	
Soluble Mass	Infinite	*(Kg)*

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	120.0			18.0	.001						
Dist. from Source (ft)	0	80	160	240	320	400	480	560	640	720	800

8. CHOOSE TYPE OF OUTPUT TO SEE:

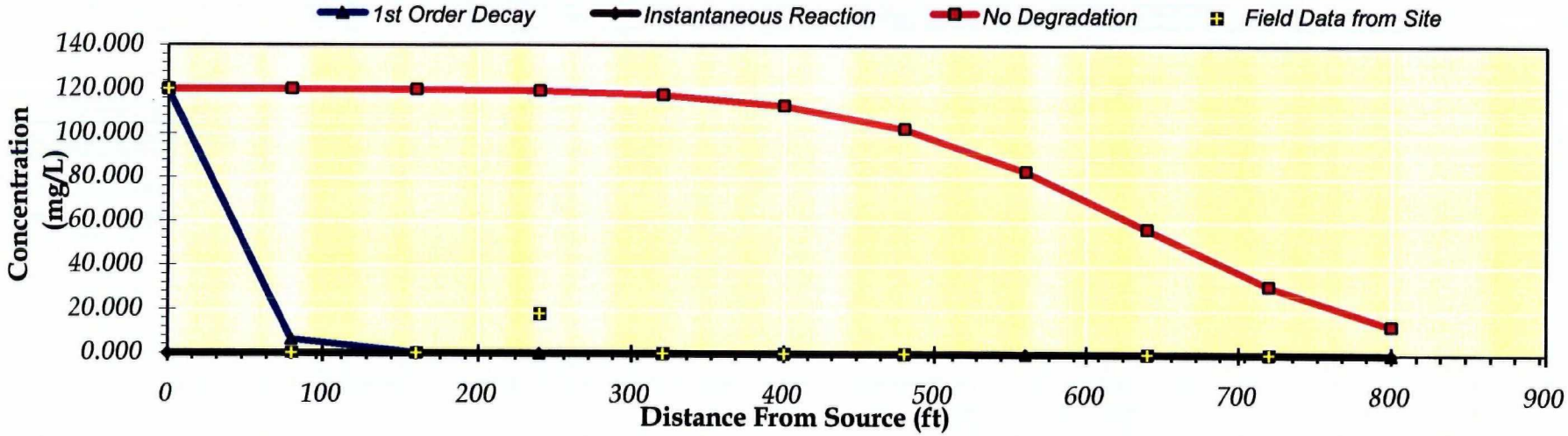
RUN CENTERLINE	**RUN ARRAY**	**Help**	Recalculate This Sheet
View Output	**View Output**	Paste Example Dataset	
		Restore Formulas for Vs, Dispersivities, R, lambda, other	

Figure 11a - Xylenes Simulation, Parameter Set 1, Bioscreen Input

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	80	160	240	320	400	480	560	640	720	800
No Degradation	120.000	119.998	119.914	119.283	117.391	112.683	102.070	82.780	56.632	31.008	13.061
1st Order Decay	120.000	6.286	0.329	0.017	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	120.0			18.000	0.001						



Calculate Animation

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 11b – Xylenes Simulation, Parameter Set 1, Centerline Output

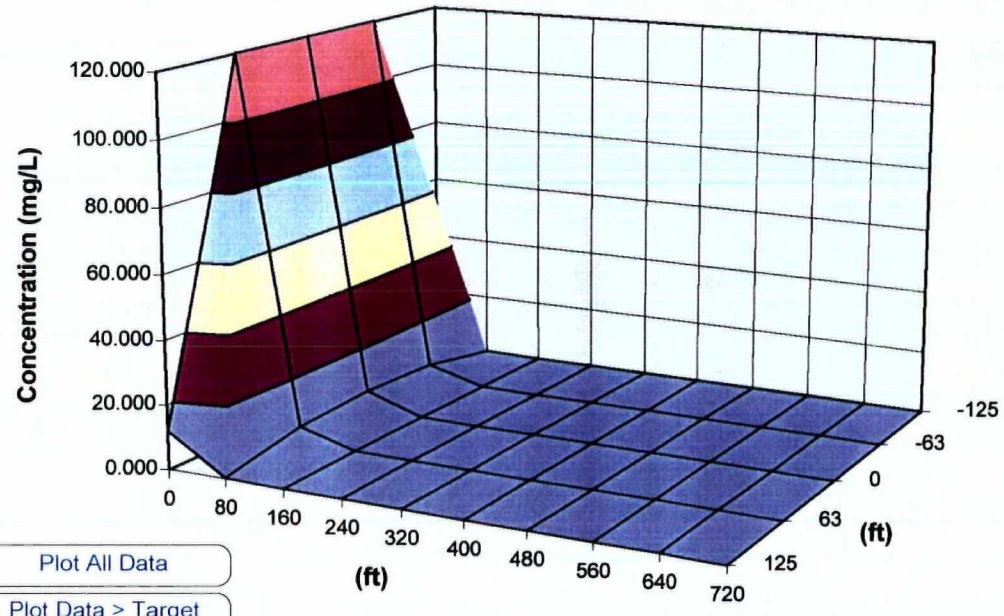
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	80	160	240	320	400	480	560	640	720	800
125	12.000	0.344	0.021	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63	120.000	5.099	0.245	0.012	0.001	0.000	0.000	0.000	0.000	0.000	0.000
0	120.000	6.286	0.329	0.017	0.001	0.000	0.000	0.000	0.000	0.000	0.000
-63	120.000	5.099	0.245	0.012	0.001	0.000	0.000	0.000	0.000	0.000	0.000
-125	12.000	0.344	0.021	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	3.3E+5	1.8E+4	9.1E+2	4.7E+1	2.5E+0	1.3E-1	6.7E-3	3.5E-4	1.8E-5	9.6E-7	5.0E-8

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model

Time: 30 Years Target Level: 0.005 mg/L Displayed Model: 1st Order Decay



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	3588.5	(Kg)
- Actual Plume Mass	87.9	(Kg)
= Plume Mass Removed by Biodeg	3500.6	(Kg) (98 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	Infinite	(Kg)
Contam. Mass in Source Now (t=30Years)	Infinite	(Kg)
Current Volume of Groundwater in Plume	6.2	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP Recalculate

Figure 11c – Xylenes Simulation, Parameter Set 1, Plume Output

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 6C Ethylbenz, MW6/MW22 — *Run Name*

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

115 ↑ or 0.02

Variable* — Data used directly in model.

20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	73.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	i	0.003	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	14.0	(ft)
Transverse Dispersivity*	alpha y	1.5	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		↑ or	
Estimated Plume Length	Lp	320	(ft)

3. ADSORPTION

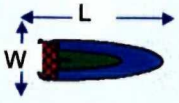
Retardation Factor*	R	4.0	(-)
or		↑ or	
Soil Bulk Density	rho		(kg/l)
Partition Coefficient	Koc		(L/kg)
FractionOrganicCarbon	foc		(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	8.0E-1	(per yr)
or		↑ or	
Solute Half-Life	t-half		(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	1100	(ft)
Modeled Area Width*	250	(ft)
Simulation Time*	30	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
50	0.1
50	2
150	16
50	2
50	0.1

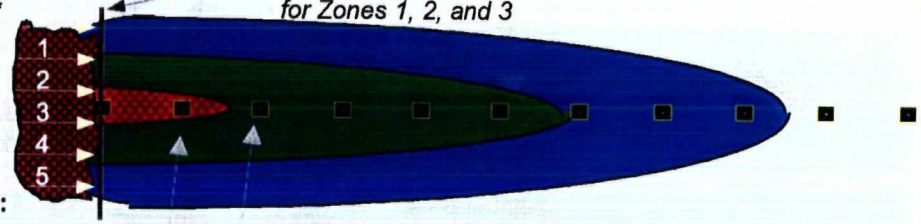
Source Halflife (see Help): (yr)

Inst. React. ↑ ↑ 1st Order

Soluble Mass: Infinite (Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	16.0		3.2	.001							
Dist. from Source (ft)	0	110	220	330	440	550	660	770	880	990	1100

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help | Recalculate This Sheet

Paste Example Dataset

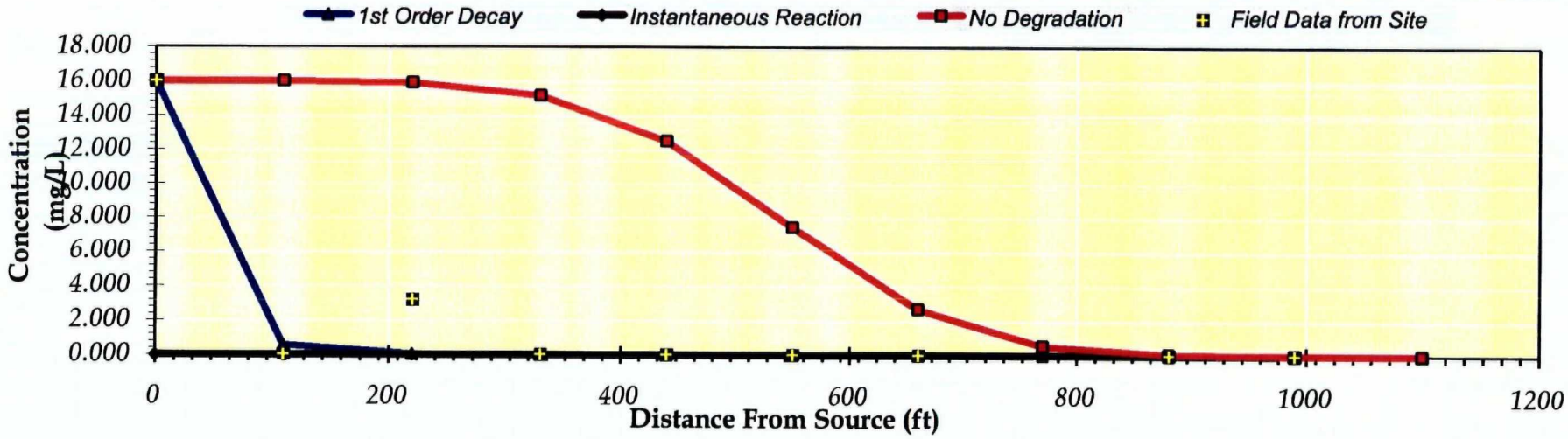
Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 12a – Ethylbenzene Simulation, Parameter Set 1, Bioscreen Input

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	110	220	330	440	550	660	770	880	990	1100
No Degradation	16.000	15.996	15.886	15.138	12.476	7.423	2.673	0.518	0.051	0.002	0.000
1st Order Decay	16.000	0.548	0.019	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	16.0		3.200	0.001							



Calculate Animation

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 12b – Ethylbenzene Simulation, Parameter Set 1, Centerline Output

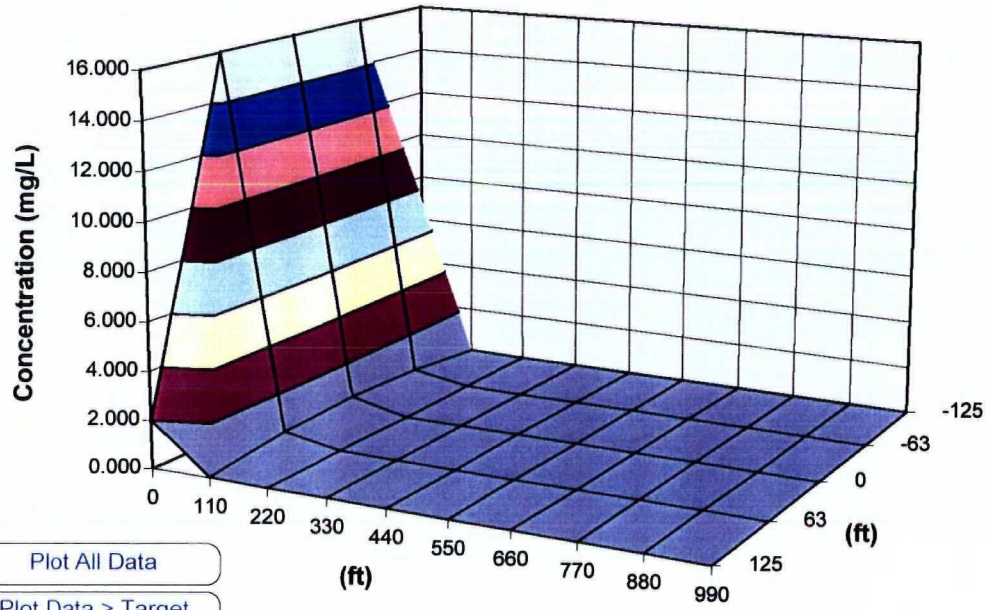
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	110	220	330	440	550	660	770	880	990	1100
125	2.000	0.037	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63	16.000	0.430	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	16.000	0.548	0.019	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-63	16.000	0.430	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-125	2.000	0.037	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	4.4E+4	1.6E+3	5.2E+1	1.8E+0	6.1E-2	2.1E-3	7.1E-5	2.4E-6	7.1E-8	1.7E-9	2.4E-11

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model

Time: **30 Years** Target Level: **0.005** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	485.3	(Kg)
- Actual Plume Mass	15.6	(Kg)
= Plume Mass Removed by Biodeg	**469.7**	(Kg) (97 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	Infinite	(Kg)
Contam. Mass in Source Now (t=30Years)	Infinite	(Kg)
Current Volume of Groundwater in Plume	6.2	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP

Recalculate

Figure 12c – Ethylbenzene Simulation, Parameter Set 1, Plume Output

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 7C
DEHP, MW6/MW22
Run Name

Data Input Instructions:

115 or 0.02

1. *Enter value directly,...or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

Variable*	*Data used directly in model.*
20	*Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	73.0	*(ft/yr)*
or		↑ or	
Hydraulic Conductivity	*K*	1.1E-02	*(cm/sec)*
Hydraulic Gradient	*i*	0.003	*(ft/ft)*
Porosity	*n*	0.3	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	14.0	*(ft)*
Transverse Dispersivity*	*alpha y*	1.5	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		↑ or	
Estimated Plume Length	*Lp*	320	*(ft)*

3. ADSORPTION

Retardation Factor*	*R*	9.0	*(-)*
or		↑ or	
Soil Bulk Density	*rho*		*(kg/l)*
Partition Coefficient	*Koc*		*(L/kg)*
FractionOrganicCarbon	*foc*		*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	3.0E-1	*(per yr)*
or		↑ or	
Solute Half-Life	*t-half*		*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	550	*(ft)*	L
Modeled Area Width*	250	*(ft)*	W
Simulation Time*	30	*(yr)*	

6. SOURCE DATA

Source Thickness in Sat.Zone* 10 *(ft)*

Source Zones:

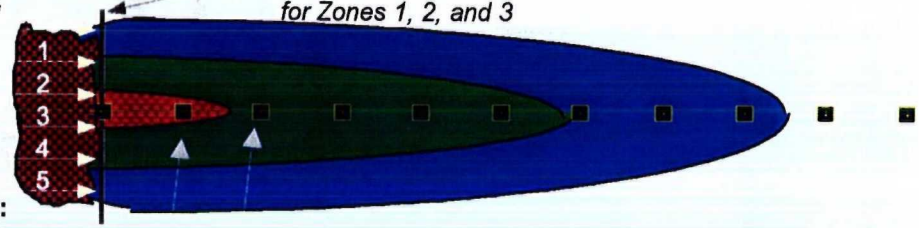
Width* (ft)	Conc. (mg/L)*
50	0.5
50	6
150	62
50	6
50	0.5

Source Halflife (see Help):

1	0.1	*(yr)*
Inst. React. ↑	↑ 1st Order	
Soluble Mass	Infinite	*(Kg)*

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	62.0						.008				
Dist. from Source (ft)	*0*	*55*	*110*	*165*	*220*	*275*	*330*	*385*	*440*	*495*	*550*

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help | Recalculate This Sheet

Paste Example Dataset

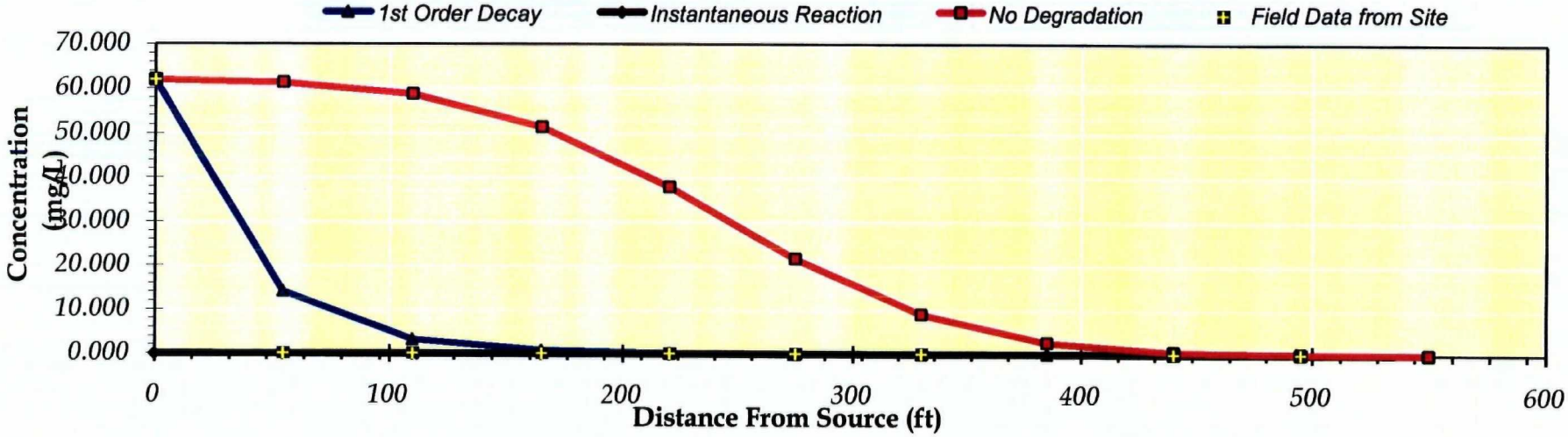
Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 13a – DEHP Simulation, Parameter Set 1, Bioscreen Input

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	55	110	165	220	275	330	385	440	495	550
No Degradation	62.000	61.302	58.705	51.344	37.780	21.561	8.965	2.604	0.514	0.068	0.006
1st Order Decay	62.000	14.140	3.225	0.734	0.166	0.037	0.008	0.001	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	62.0						0.008				



Calculate Animation

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 13b – DEHP Simulation, Parameter Set 1, Centerline Output

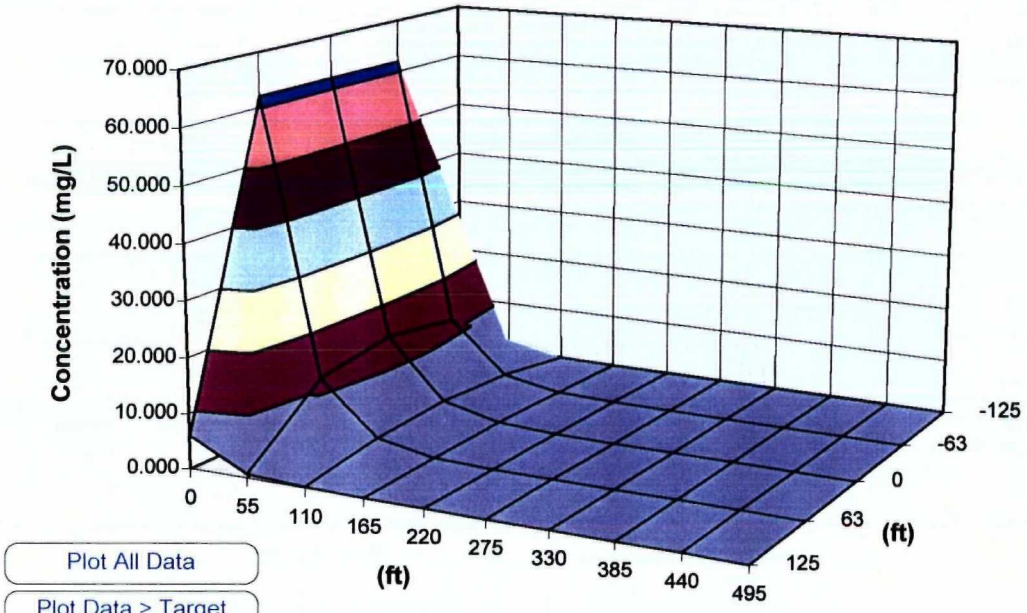
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	55	110	165	220	275	330	385	440	495	550
125	6.000	0.742	0.178	0.047	0.013	0.003	0.001	0.000	0.000	0.000	0.000
63	62.000	12.030	2.509	0.544	0.119	0.026	0.005	0.001	0.000	0.000	0.000
0	62.000	14.140	3.225	0.734	0.166	0.037	0.008	0.001	0.000	0.000	0.000
-63	62.000	12.030	2.509	0.544	0.119	0.026	0.005	0.001	0.000	0.000	0.000
-125	6.000	0.742	0.178	0.047	0.013	0.003	0.001	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	1.7E+5	4.2E+4	9.1E+3	2.0E+3	4.6E+2	1.0E+2	2.1E+1	3.7E+0	5.3E-1	5.7E-2	4.3E-3

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model

Time: **30 Years** Target Level: **0.005** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	1850.0	(Kg)
- Actual Plume Mass	41.2	(Kg)
= Plume Mass Removed by Biodeg	1808.8	(Kg) (98 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	Infinite	(Kg)
Contam. Mass in Source Now (t=30Years)	Infinite	(Kg)
Current Volume of Groundwater in Plume	7.3	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP

Recalculate

Figure 13c – DEHP Simulation, Parameter Set 1, Plume Output

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 5I
Xylenes, MW6/MW22
Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	73.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	i	0.003	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	14.0	(ft)
Transverse Dispersivity*	alpha y	1.5	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	320	(ft)

3. ADSORPTION

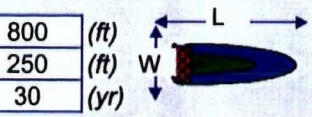
Retardation Factor*	R	3.4	(-)
or		or	
Soil Bulk Density	rho		(kg/l)
Partition Coefficient	Koc		(L/kg)
FractionOrganicCarbon	foc		(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.2E+0	(per yr)
or		or	
Solute Half-Life	t-half		(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	800	(ft)
Modeled Area Width*	250	(ft)
Simulation Time*	30	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

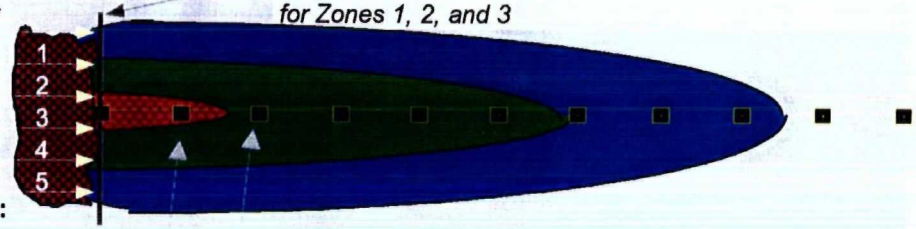
Source Zones:

Width* (ft)	Conc. (mg/L)*
50	1
50	13
150	127
50	13
50	1

Source Halflife (see Help):

	400	(yr)
Inst. React.	1st Order	
Soluble Mass	70000	(Kg)
In Source NAPL, Soil		

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	120.0
80	
160	
240	18.0
320	.001
400	
480	
560	
640	
720	
800	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

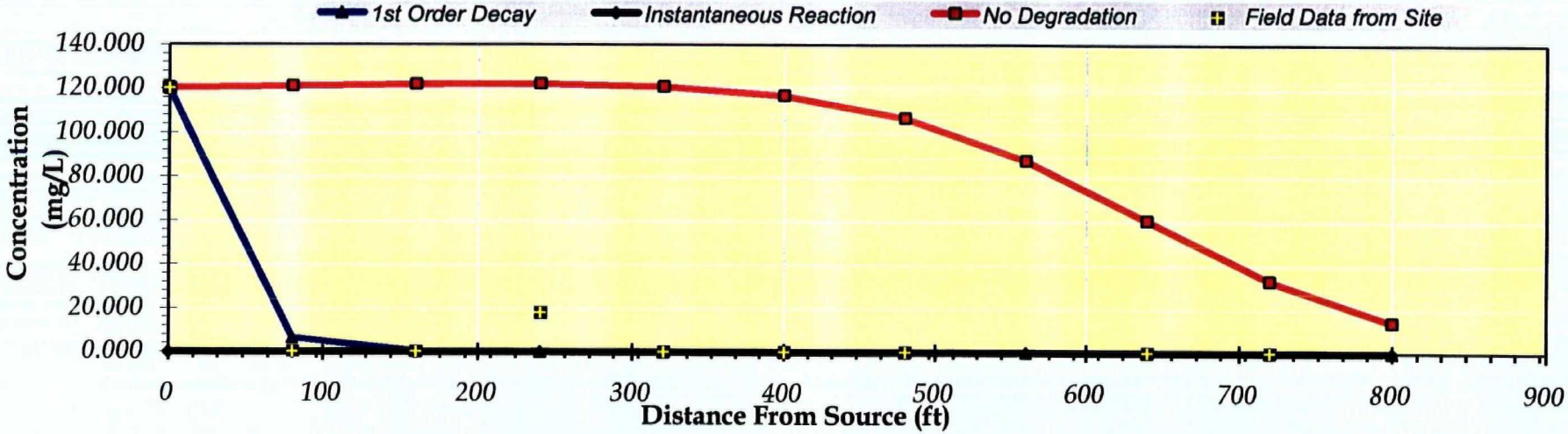
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 14a – Xylenes Simulation, Parameter Set 2, Bioscreen Input

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	80	160	240	320	400	480	560	640	720	800
No Degradation	120.286	121.098	121.833	122.013	120.894	116.834	106.551	87.004	59.928	32.825	13.827
1st Order Decay	120.286	6.344	0.334	0.018	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	120.0			18.000	0.001						



Calculate Animation

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 14b – Xylenes Simulation, Parameter Set 2, Centerline Output

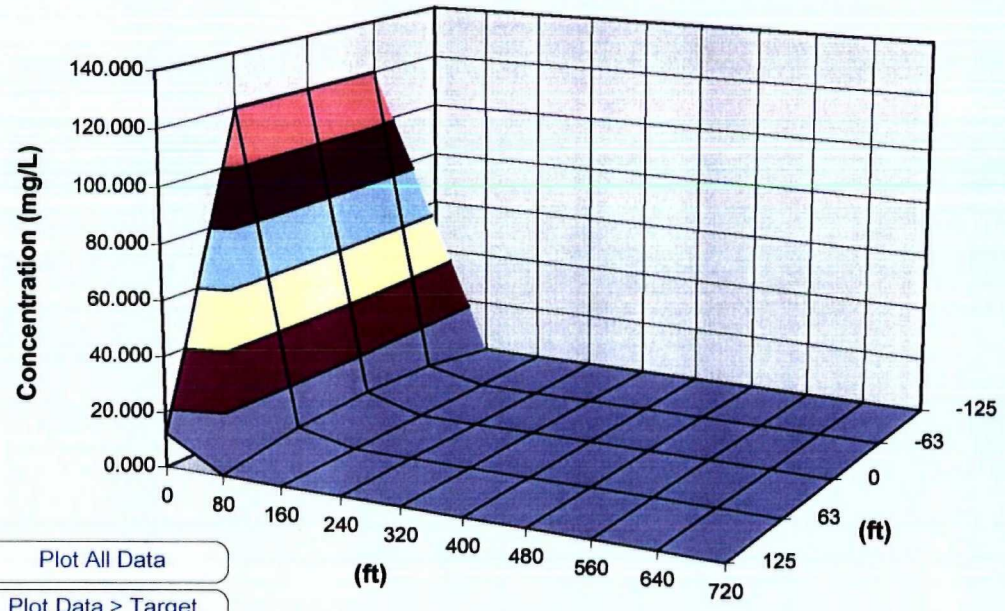
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft)	0	80	160	240	320	400	480	560	640	720	800
125	12.313	0.353	0.022	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63	120.286	5.149	0.249	0.013	0.001	0.000	0.000	0.000	0.000	0.000	0.000
0	120.286	6.344	0.334	0.018	0.001	0.000	0.000	0.000	0.000	0.000	0.000
-63	120.286	5.149	0.249	0.013	0.001	0.000	0.000	0.000	0.000	0.000	0.000
-125	12.313	0.353	0.022	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	3.5E+5	1.8E+4	9.3E+2	4.8E+1	2.5E+0	1.3E-1	7.0E-3	3.7E-4	1.9E-5	1.0E-6	5.3E-8

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model

Time: 30 Years Target Level: 0.005 mg/L Displayed Model: 1st Order Decay



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	3700.9	(Kg)
- Actual Plume Mass	88.3	(Kg)
= Plume Mass Removed by Biodeg	3612.6	(Kg) (98 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	70000.0	(Kg)
Contam. Mass in Source Now (t=30Years)	66299.1	(Kg)
Current Volume of Groundwater in Plume	6.2	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP Recalculate

Figure 14c – Xylenes Simulation, Parameter Set 2, Plume Output

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 6B
Ethylbenz, MW6/MW22
Run Name

Data Input Instructions:

1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

115 or 0.02

Variable*		*Data used directly in model.*
20		*Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	73.0	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	1.1E-02	*(cm/sec)*
Hydraulic Gradient	*i*	0.003	*(ft/ft)*
Porosity	*n*	0.3	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	14.0	*(ft)*
Transverse Dispersivity*	*alpha y*	1.5	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		or	
Estimated Plume Length	*Lp*	320	*(ft)*

3. ADSORPTION

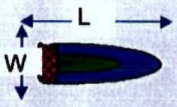
Retardation Factor*	*R*	4.0	*(-)*
or		or	
Soil Bulk Density	*rho*		*(kg/l)*
Partition Coefficient	*Koc*		*(L/kg)*
FractionOrganicCarbon	*foc*		*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	8.0E-1	*(per yr)*
or		or	
Solute Half-Life	*t-half*		*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	1100	*(ft)*
Modeled Area Width*	250	*(ft)*
Simulation Time*	30	*(yr)*



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 *(ft)*

Source Zones:

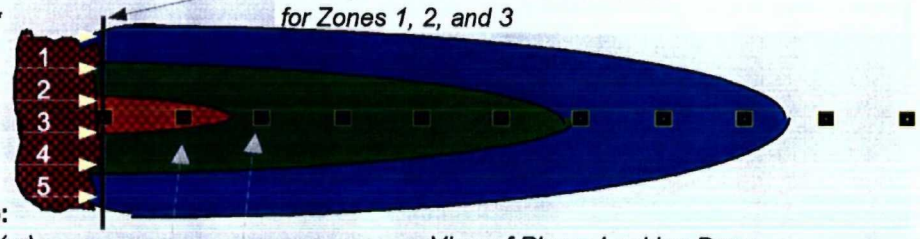
Width* (ft)	Conc. (mg/L)*
50	0.1
50	2
150	17
50	2
50	0.1

Source Halflife (see Help):

1	400	*(yr)*
Inst. React.	1st Order	
Soluble Mass	10000	*(Kg)*

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	16.0		3.2	.001							
Dist. from Source (ft)	0	110	220	330	440	550	660	770	880	990	1100

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

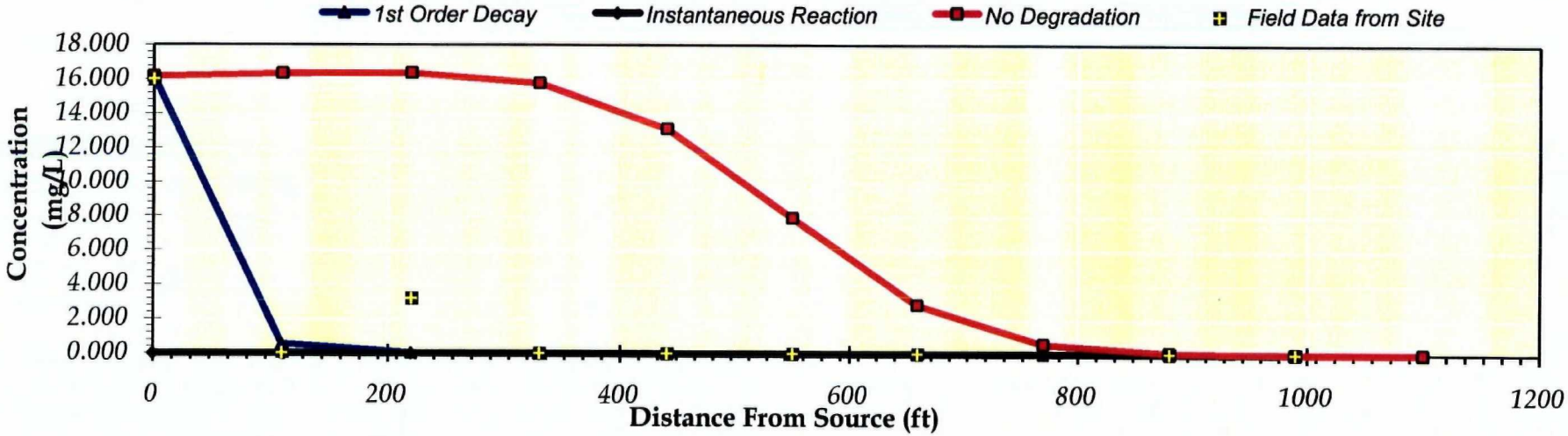
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 15a - Ethylbenzene Simulation, Parameter Set 2, Bioscreen Input

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	110	220	330	440	550	660	770	880	990	1100
No Degradation	16.150	16.313	16.368	15.757	13.119	7.883	2.838	0.550	0.054	0.003	0.000
1st Order Decay	16.150	0.559	0.019	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	16.0		3.200	0.001							



Calculate Animation

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 15b - Ethylbenzene Simulation, Parameter Set 2, Centerline Output

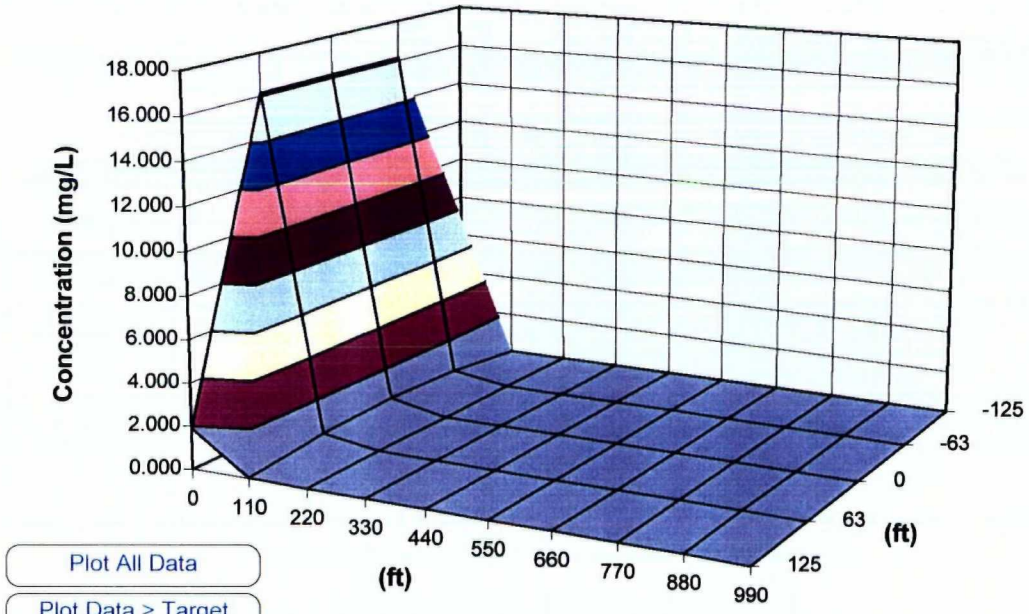
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	110	220	330	440	550	660	770	880	990	1100
125	1.900	0.036	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63	16.150	0.438	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	16.150	0.559	0.019	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-63	16.150	0.438	0.014	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-125	1.900	0.036	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	4.7E+4	1.6E+3	5.4E+1	1.8E+0	6.4E-2	2.2E-3	7.5E-5	2.5E-6	7.6E-8	1.7E-9	2.6E-11

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model

Time: **30 Years** Target Level: **0.005** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	500.2	(Kg)
- Actual Plume Mass	15.7	(Kg)
= Plume Mass Removed by Biodeg	**484.5**	(Kg) (97 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	10000.0	(Kg)
Contam. Mass in Source Now (t=30Years)	9499.8	(Kg)
Current Volume of Groundwater in Plume	6.2	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP

Recalculate

Figure 15c - Ethylbenzene Simulation, Parameter Set 2, Plume Output

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 7D DEHP MW6/MW22 — *Run Name*

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.

Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	73.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	i	0.003	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	14.0	(ft)
Transverse Dispersivity*	alpha y	1.5	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	320	(ft)

3. ADSORPTION

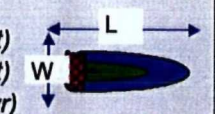
Retardation Factor*	R	9.0	(-)
or		or	
Soil Bulk Density	rho		(kg/l)
Partition Coefficient	Koc		(L/kg)
FractionOrganicCarbon	foc		(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.0E-1	(per yr)
or		or	
Solute Half-Life	t-half		(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	550	(ft)
Modeled Area Width*	250	(ft)
Simulation Time*	30	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
50	0.5
50	6
150	63
50	6
50	0.5

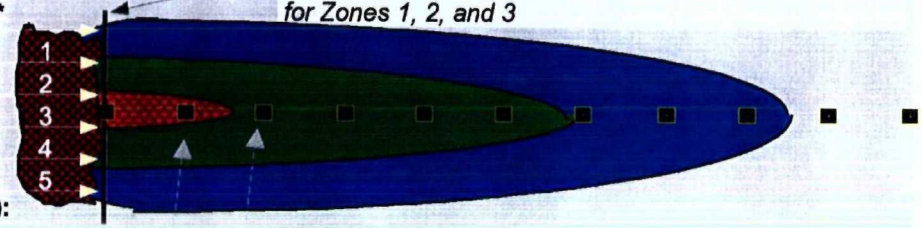
Source Halflife (see Help):

1	>1000	(yr)
Inst. React.	1st Order	

Soluble Mass 100000 (Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	62.0						.008				
Dist. from Source (ft)	0	55	110	165	220	275	330	385	440	495	550

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help — Recalculate This Sheet

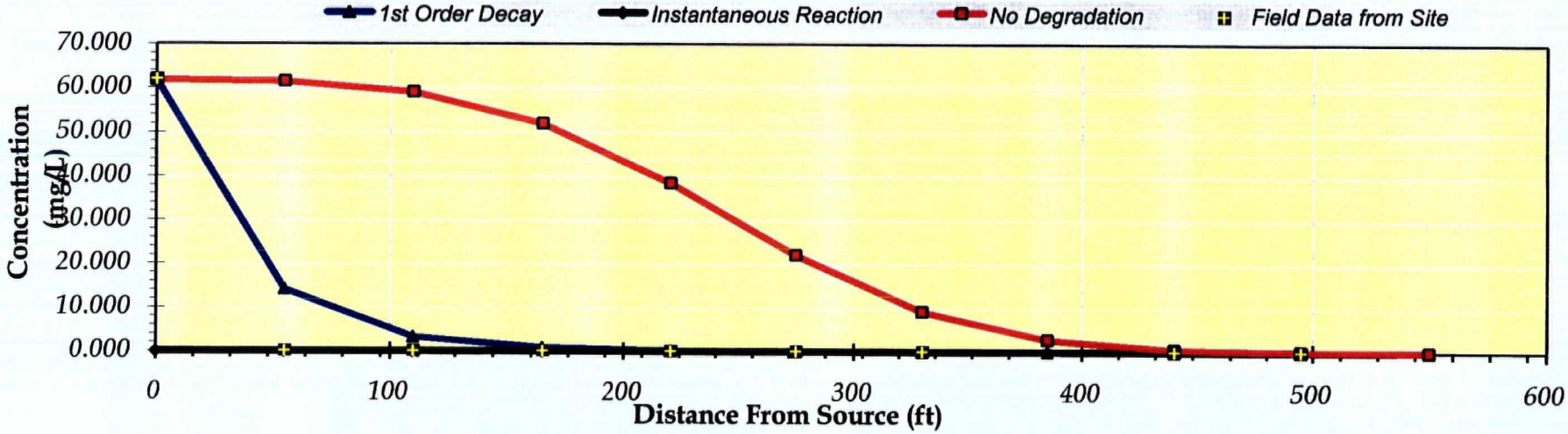
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 16a - DEHP Simulation, Parameter Set 2, Bioscreen Input

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	55	110	165	220	275	330	385	440	495	550
No Degradation	61.828	61.392	59.041	51.858	38.320	21.909	9.109	2.645	0.522	0.069	0.006
1st Order Decay	61.828	14.161	3.243	0.742	0.169	0.037	0.008	0.001	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	62.0						0.008				



Calculate Animation

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 16b - DEHP Simulation, Parameter Set 2, Centerline Output

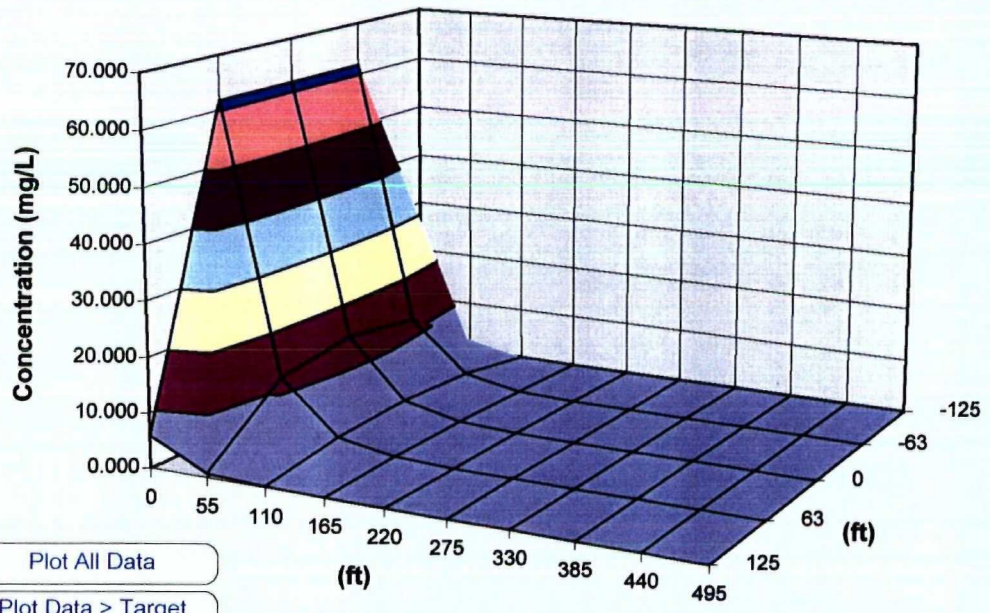
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft)	0	55	110	165	220	275	330	385	440	495	550
125	5.888	0.731	0.176	0.046	0.013	0.003	0.001	0.000	0.000	0.000	0.000
63	61.828	12.044	2.522	0.549	0.121	0.026	0.005	0.001	0.000	0.000	0.000
0	61.828	14.161	3.243	0.742	0.169	0.037	0.008	0.001	0.000	0.000	0.000
-63	61.828	12.044	2.522	0.549	0.121	0.026	0.005	0.001	0.000	0.000	0.000
-125	5.888	0.731	0.176	0.046	0.013	0.003	0.001	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	1.7E+5	4.2E+4	9.2E+3	2.1E+3	4.6E+2	1.0E+2	2.1E+1	3.8E+0	5.4E-1	5.8E-2	4.4E-3

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model

Time: 30 Years Target Level: 0.005 mg/L Displayed Model: 1st Order Decay



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	1860.4	(Kg)
- Actual Plume Mass	41.1	(Kg)
= Plume Mass Removed by Biodeg	1819.2	(Kg) (98 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	100000.0	(Kg)
Contam. Mass in Source Now (t=30Years)	98139.6	(Kg)
Current Volume of Groundwater in Plume	7.3	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP Recalculate

Figure 16c - DEHP Simulation, Parameter Set 2, Plume Output

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 8B
Xylenes, MW6/MW22
Run Name

Data Input Instructions:

115 or 0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	73.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	i	0.003	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	14.0	(ft)
Transverse Dispersivity*	alpha y	1.5	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	320	(ft)

3. ADSORPTION

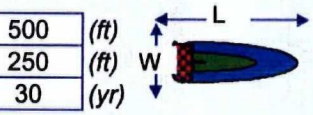
Retardation Factor*	R	3.4	(-)
or		or	
Soil Bulk Density	rho		(kg/l)
Partition Coefficient	Koc		(L/kg)
FractionOrganicCarbon	foc		(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.6E+0	(per yr)
or		or	
Solute Half-Life	t-half		(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	500	(ft)
Modeled Area Width*	250	(ft)
Simulation Time*	30	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
50	1
50	12
150	120
50	12
50	1

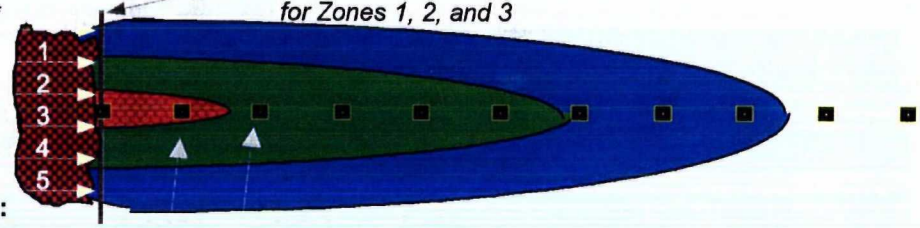
Source Halflife (see Help): (yr)

Inst. React. — 1st Order

Soluble Mass: Infinite (Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	120.0
50	
100	1.3
150	
200	
250	
300	
350	
400	
450	
500	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

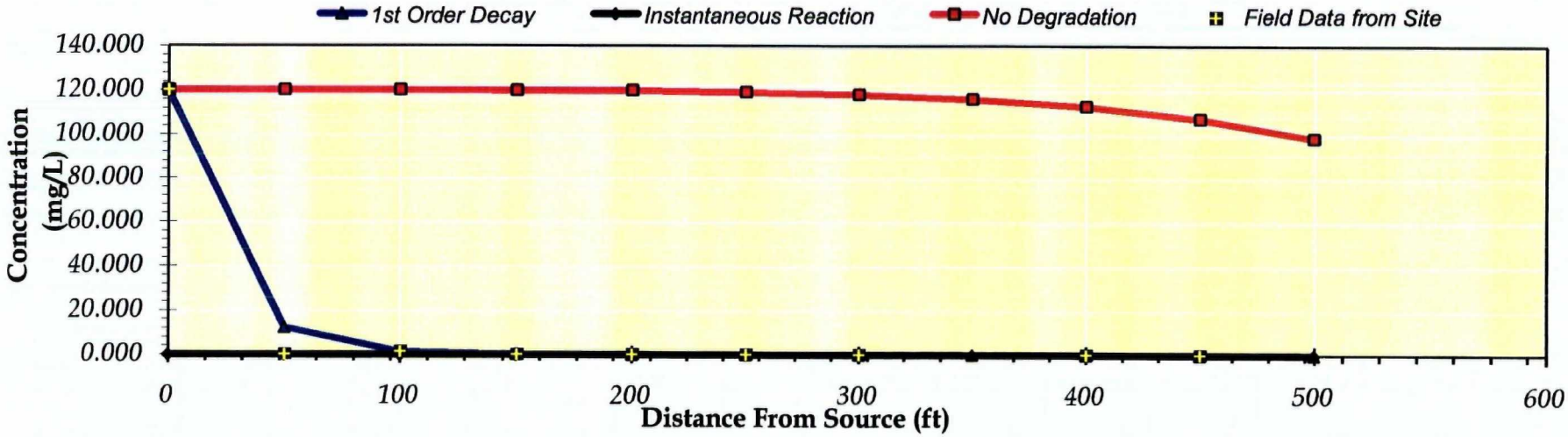
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 17a - Xylenes Simulation, Alternate Flowline, Bioscreen Input

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

TYPE OF MODEL	Distance from Source (ft) 0	50	100	150	200	250	300	350	400	450	500
No Degradation	120.000	119.999	119.995	119.942	119.706	119.134	118.042	116.091	112.683	106.971	98.100
1st Order Decay	120.000	12.326	1.266	0.130	0.013	0.001	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	120.0		1.300								



Calculate Animation

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 17b - Xylenes Simulation, Alternate Flowline, Centerline Output

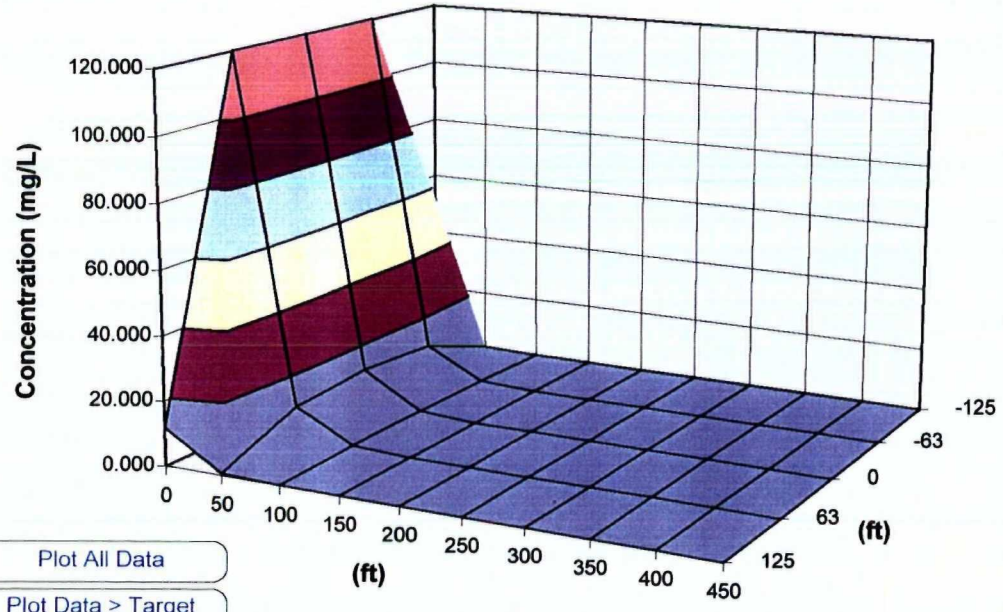
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	50	100	150	200	250	300	350	400	450	500
125	12.000	0.668	0.071	0.008	0.001	0.000	0.000	0.000	0.000	0.000	0.000
63	120.000	10.620	0.998	0.097	0.010	0.001	0.000	0.000	0.000	0.000	0.000
0	120.000	12.326	1.266	0.130	0.013	0.001	0.000	0.000	0.000	0.000	0.000
-63	120.000	10.620	0.998	0.097	0.010	0.001	0.000	0.000	0.000	0.000	0.000
-125	12.000	0.668	0.071	0.008	0.001	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	3.3E+5	3.7E+4	3.6E+3	3.6E+2	3.7E+1	3.8E+0	3.8E-1	3.9E-2	4.0E-3	4.1E-4	4.3E-5

Model to Display:

- *No Degradation Model*
- *1st Order Decay Model*
- *Instantaneous Reaction Model*

Time: **30 Years** Target Level: **0.005** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	3588.5	(Kg)
- Actual Plume Mass	75.1	(Kg)
= Plume Mass Removed by Biodeg	3513.4	(Kg) (98 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	Infinite	(Kg)
Contam. Mass in Source Now (t=30Years)	Infinite	(Kg)
Current Volume of Groundwater in Plume	5.0	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP

Recalculate

Figure 17c - Xylenes Simulation, Alternate Flowline, Plume Output

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 8A
Ethylbenzene, MW6/MW2
Run Name

Data Input Instructions:

1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

*Variable** — *Data used directly in model.*
Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	73.0	*(ft/yr)*
or		↑ or	
Hydraulic Conductivity	*K*	1.1E-02	*(cm/sec)*
Hydraulic Gradient	*i*	0.003	*(ft/ft)*
Porosity	*n*	0.3	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	14.0	*(ft)*
Transverse Dispersivity*	*alpha y*	1.5	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		↑ or	
Estimated Plume Length	*Lp*	320	*(ft)*

3. ADSORPTION

Retardation Factor*	*R*	4.0	*(-)*
or		↑ or	
Soil Bulk Density	*rho*		*(kg/l)*
Partition Coefficient	*Koc*		*(L/kg)*
FractionOrganicCarbon	*foc*		*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	2.0E+0	*(per yr)*
or		↑ or	
Solute Half-Life	*t-half*		*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	250	*(ft)*	L
Modeled Area Width*	250	*(ft)*	W
Simulation Time*	30	*(yr)*	

115 ↑ or 0.02

6. SOURCE DATA

Source Thickness in Sat.Zone* 10 *(ft)*

Source Zones:

Width* (ft)	Conc. (mg/L)*
50	0.1
50	1.6
150	16
50	1.6
50	1

Source Halflife (see Help):

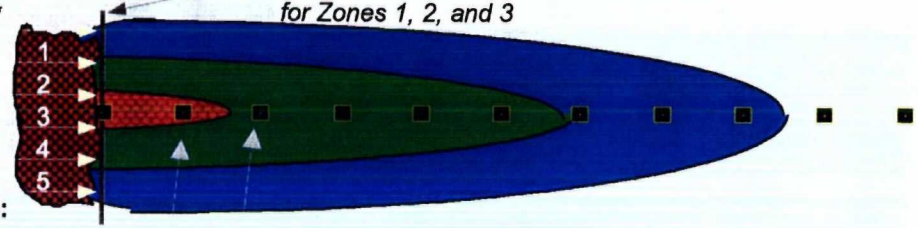
(yr)

Inst. React. ↑ ↑ 1st Order

Soluble Mass: Infinite *(Kg)*

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	16.0
25	
50	
75	
100	.039
125	
150	
175	
200	
225	
250	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help — Recalculate This Sheet

Paste Example Dataset

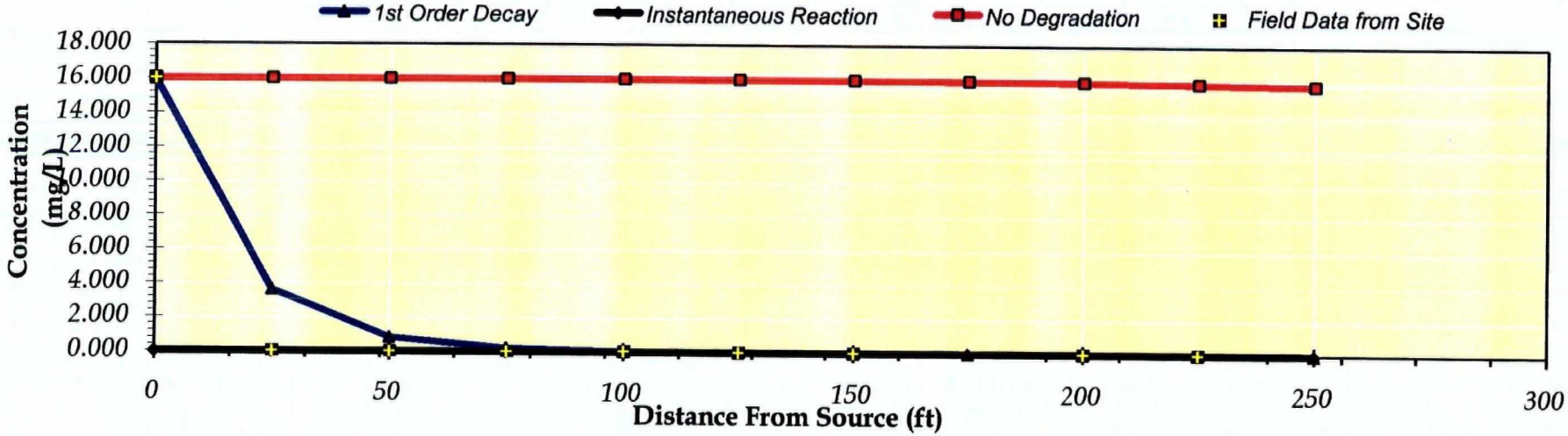
Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 18a - Ethylbenzene Simulation, Alternate Flowline, Bioscreen Input

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	25	50	75	100	125	150	175	200	225	250
No Degradation	16.000	16.000	16.000	15.999	15.997	15.993	15.984	15.964	15.928	15.871	15.782
1st Order Decay	16.000	3.597	0.809	0.182	0.041	0.009	0.002	0.000	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	16.0				0.039						



Calculate Animation

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 18b - Ethylbenzene Simulation, Alternate Flowline, Centerline Output

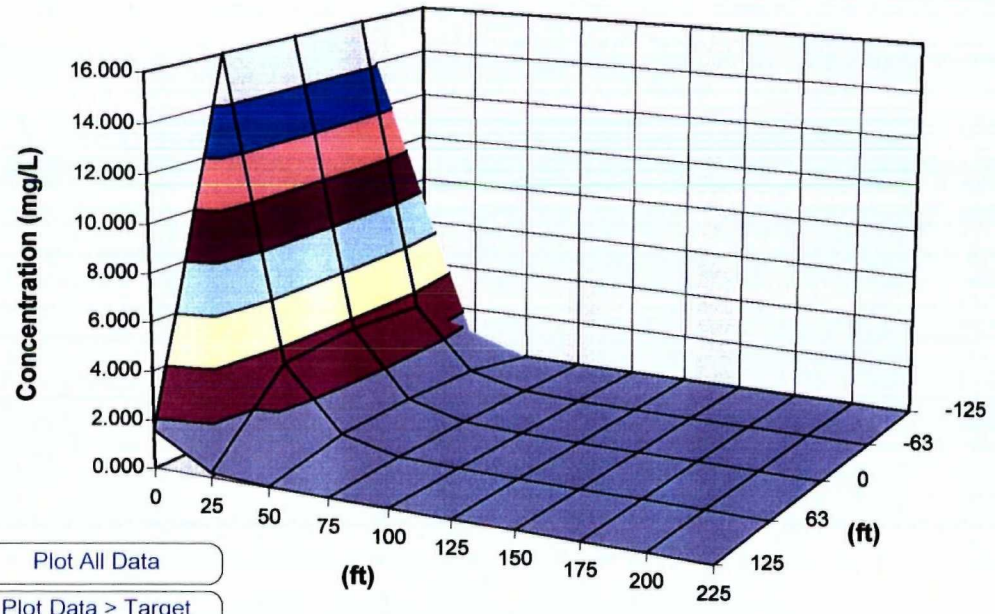
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	25	50	75	100	125	150	175	200	225	250
125	1.600	0.191	0.043	0.010	0.002	0.001	0.000	0.000	0.000	0.000	0.000
63	16.000	3.356	0.697	0.149	0.032	0.007	0.002	0.000	0.000	0.000	0.000
0	16.000	3.597	0.809	0.182	0.041	0.009	0.002	0.000	0.000	0.000	0.000
-63	16.000	3.356	0.697	0.149	0.032	0.007	0.002	0.000	0.000	0.000	0.000
-125	1.600	0.191	0.043	0.010	0.002	0.001	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	4.4E+4	1.1E+4	2.4E+3	5.3E+2	1.2E+2	2.6E+1	5.7E+0	1.3E+0	2.9E-1	6.4E-2	1.4E-2

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model

Time: **30 Years** Target Level: **0.005** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	477.8	(Kg)
- Actual Plume Mass	10.3	(Kg)
= Plume Mass Removed by Biodeg	**467.5**	(Kg) (98 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	Infinite	(Kg)
Contam. Mass in Source Now (t=30Years)	Infinite	(Kg)
Current Volume of Groundwater in Plume	2.8	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP

Recalculate

Figure 18c - Ethylbenzene Simulation, Alternate Flowline, Plume Output

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 8C
DEHP, MW6/MW2
Run Name

Data Input Instructions:

115 / or / 0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	73.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	i	0.003	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	14.0	(ft)
Transverse Dispersivity*	alpha y	1.5	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	320	(ft)

3. ADSORPTION

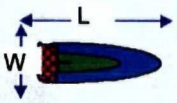
Retardation Factor*	R	9.0	(-)
or		or	
Soil Bulk Density	rho		(kg/l)
Partition Coefficient	Koc		(L/kg)
FractionOrganicCarbon	foc		(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.7E+0	(per yr)
or		or	
Solute Half-Life	t-half		(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	250	(ft)
Modeled Area Width*	250	(ft)
Simulation Time*	30	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
50	0.6
50	6
150	62
50	6
50	0.6

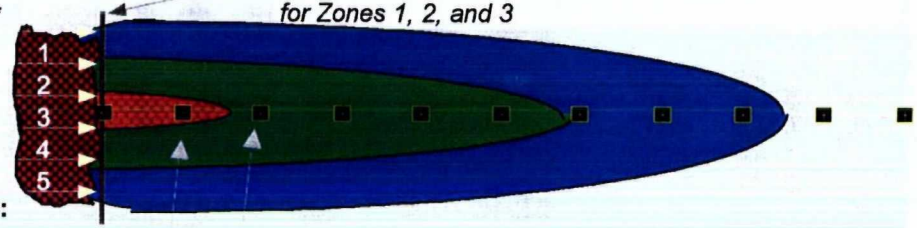
Source Halflife (see Help): (yr)

Inst. React. / 1st Order

Soluble Mass: Infinite (Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	62.0
25	
50	
75	
100	.007
125	
150	
175	
200	
225	
250	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help — Recalculate This Sheet

Paste Example Dataset

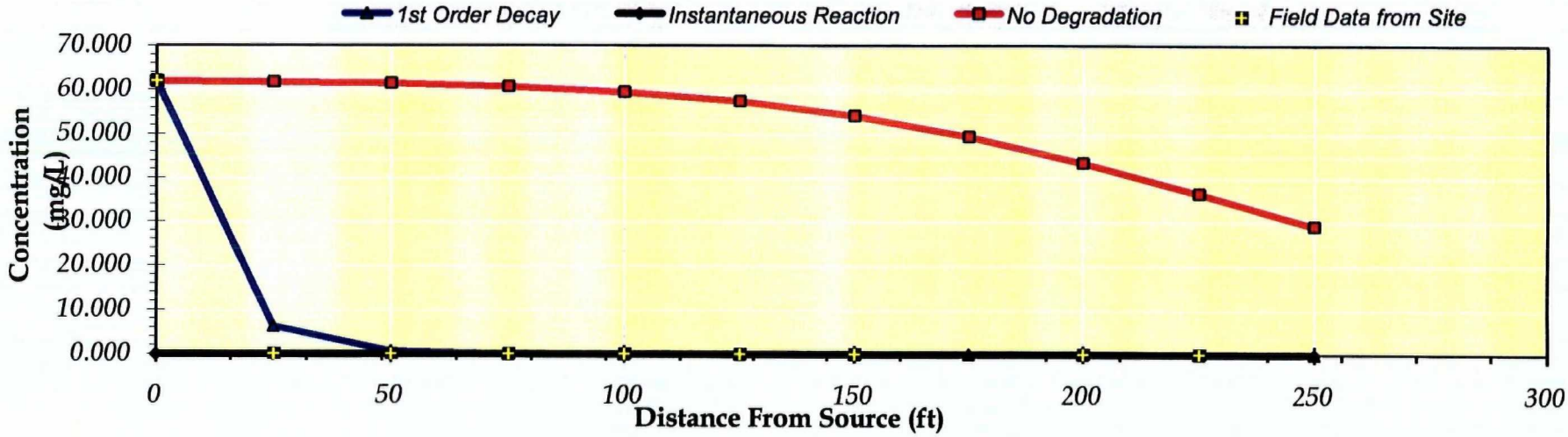
Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 19a - DEHP Simulation Alternate Flowline, Bioscreen Input

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	25	50	75	100	125	150	175	200	225	250
No Degradation	62.000	61.747	61.406	60.716	59.442	57.292	53.977	49.312	43.326	36.321	28.843
1st Order Decay	62.000	6.256	0.631	0.064	0.006	0.001	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	62.0				0.007						



Calculate Animation

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 19b - DEHP Simulation Alternate Flowline, Centerline Output

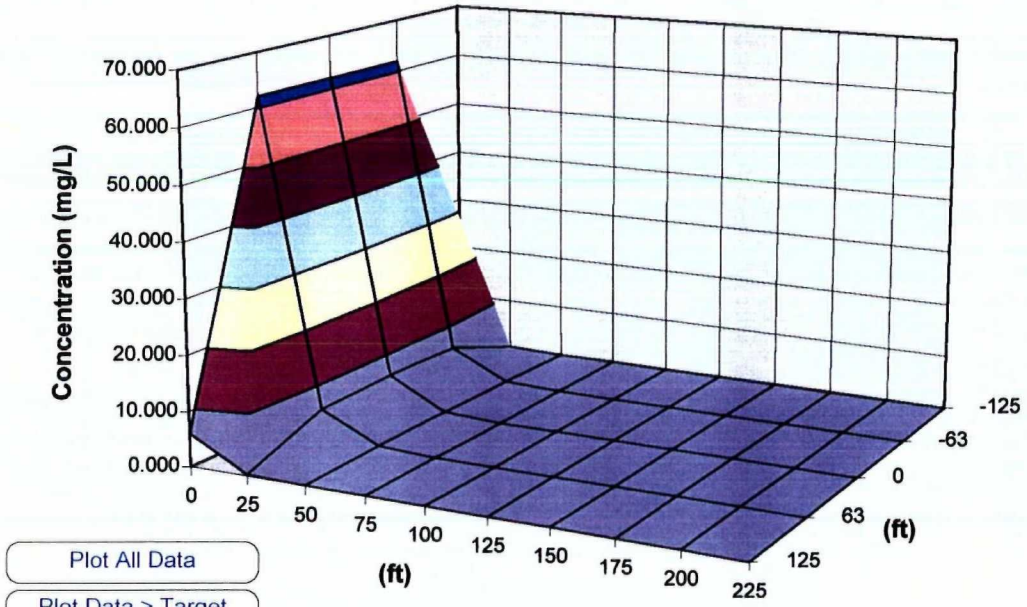
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	25	50	75	100	125	150	175	200	225	250
125	6.000	0.333	0.034	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63	62.000	5.835	0.544	0.052	0.005	0.000	0.000	0.000	0.000	0.000	0.000
0	62.000	6.256	0.631	0.064	0.006	0.001	0.000	0.000	0.000	0.000	0.000
-63	62.000	5.835	0.544	0.052	0.005	0.000	0.000	0.000	0.000	0.000	0.000
-125	6.000	0.333	0.034	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	1.7E+5	2.0E+4	1.9E+3	1.9E+2	1.8E+1	1.8E+0	1.8E-1	1.8E-2	1.8E-3	1.8E-4	1.9E-5

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model

Time: **30 Years** Target Level: **0.005** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	1851.9	(Kg)
- Actual Plume Mass	16.6	(Kg)
= Plume Mass Removed by Biodeg	1835.3	(Kg) (99 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	Infinite	(Kg)
Contam. Mass in Source Now (t=30Years)	Infinite	(Kg)
Current Volume of Groundwater in Plume	2.3	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP

Recalculate

Figure 19c - DEHP Simulation Alternate Flowline, Plume Output

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 9A (2 Xylenes, MW6/MW22
Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	73.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	i	0.003	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	14.0	(ft)
Transverse Dispersivity*	alpha y	1.5	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	320	(ft)

3. ADSORPTION

Retardation Factor*	R	3.4	(-)
or		or	
Soil Bulk Density	rho		(kg/l)
Partition Coefficient	Koc		(L/kg)
FractionOrganicCarbon	foc		(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.2E+0	(per yr)
or		or	
Solute Half-Life	t-half		(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	800	(ft)
Modeled Area Width*	250	(ft)
Simulation Time*	30	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

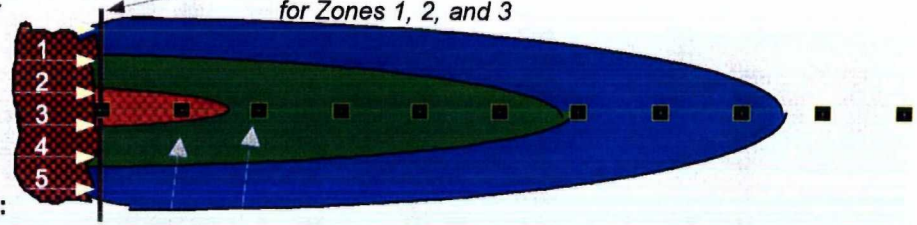
Source Zones:

Width* (ft)	Conc. (mg/L)*
50	0.2
50	2.3
150	23
50	2.3
50	0.2

Source Halflife (see Help):

		(yr)
Inst. React.	1st Order	
Soluble Mass	Infinite	(Kg)
In Source NAPL, Soil		

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	23.0
80	
160	
240	3.6
320	.0
400	
480	
560	
640	
720	
800	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

Paste Example Dataset

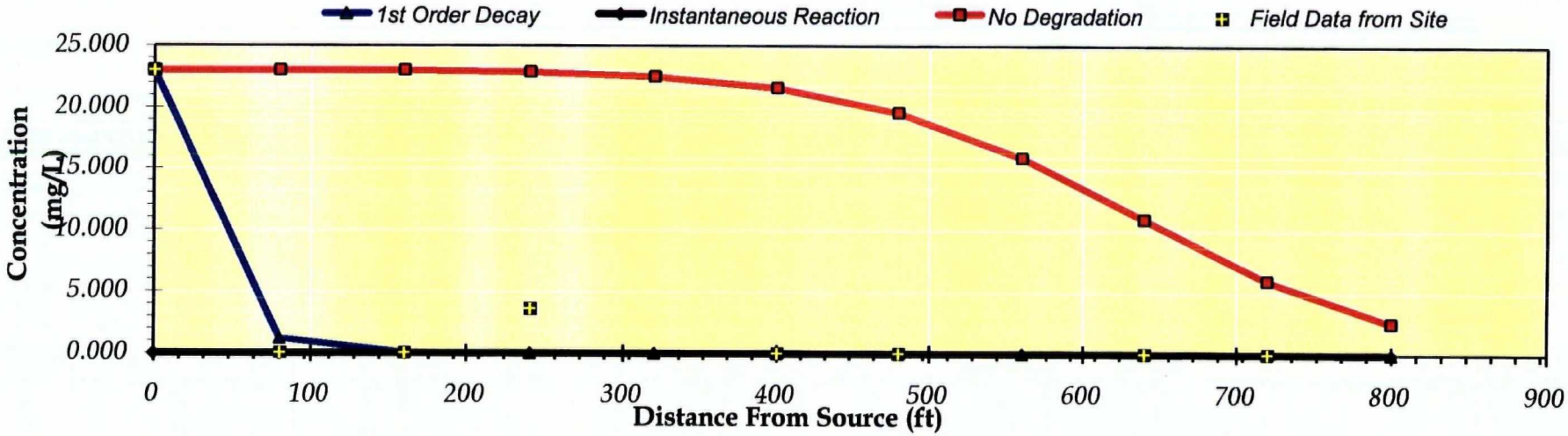
Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 20a
Xylenes Simulation, Parameter Set 1,
Bioscreen Input, Year 2000

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	80	160	240	320	400	480	560	640	720	800
No Degradation	23.000	23.000	22.984	22.863	22.500	21.598	19.563	15.866	10.855	5.943	2.503
1st Order Decay	23.000	1.205	0.063	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	23.0			3.600	0.000						



Calculate Animation

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 20b
Xylenes Simulation, Parameter Set 1,
Centerline Output, Year 2000

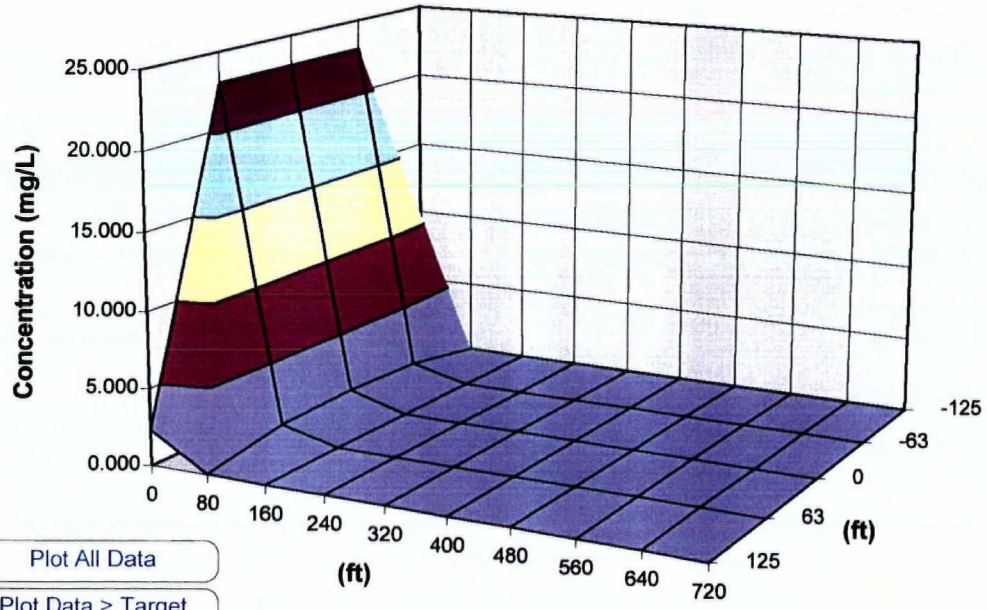
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft)	0	80	160	240	320	400	480	560	640	720	800
125	2.300	0.066	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63	23.000	0.977	0.047	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	23.000	1.205	0.063	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-63	23.000	0.977	0.047	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-125	2.300	0.066	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	6.3E+4	3.5E+3	1.8E+2	9.1E+0	4.7E-1	2.5E-2	1.3E-3	6.7E-5	3.5E-6	1.8E-7	9.6E-9

Model to Display:

- *No Degradation Model*
- *1st Order Decay Model*
- *Instantaneous Reaction Model*

Time: **30 Years** Target Level: **0.005** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	687.9	(Kg)
- Actual Plume Mass	16.8	(Kg)
= Plume Mass Removed by Biodeg	671.1	(Kg) (98 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	Infinite	(Kg)
Contam. Mass in Source Now (t=30Years)	Infinite	(Kg)
Current Volume of Groundwater in Plume	4.5	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP

Recalculate

Figure 20c
Xylenes Simulation, Parameter Set 1,
Plume Output, Year 2000

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 9B (2 Ethylbenz, MW6/MW22 — *Run Name*

Data Input Instructions:

1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

115 ↑ or 0.02

Variable*	*Data used directly in model.*
20	*Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	73.0	*(ft/yr)*
or		↑ or	
Hydraulic Conductivity	*K*	1.1E-02	*(cm/sec)*
Hydraulic Gradient	*i*	0.003	*(ft/ft)*
Porosity	*n*	0.3	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	14.0	*(ft)*
Transverse Dispersivity*	*alpha y*	1.5	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		↑ or	
Estimated Plume Length	*Lp*	320	*(ft)*

3. ADSORPTION

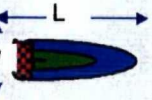
Retardation Factor*	*R*	4.0	*(-)*
or		↑ or	
Soil Bulk Density	*rho*		*(kg/l)*
Partition Coefficient	*Koc*		*(L/kg)*
FractionOrganicCarbon	*foc*		*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	8.0E-1	*(per yr)*
or		↑ or	
Solute Half-Life	*t-half*		*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	1100	*(ft)*
Modeled Area Width*	250	*(ft)*
Simulation Time*	30	*(yr)*



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 *(ft)*

Source Zones:

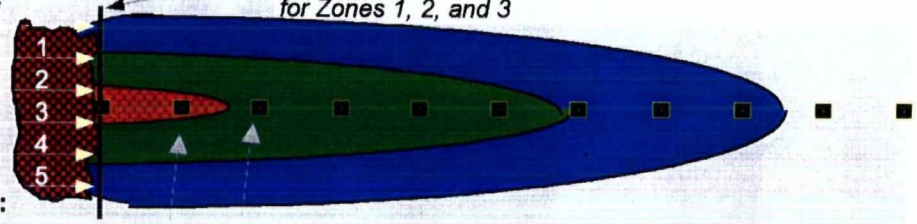
Width* (ft)	Conc. (mg/L)*
50	0.1
50	0.5
150	5.2
50	0.5
50	0.1

Source Halflife (see Help):

		(yr)
Inst. React. ↑	↑ 1st Order	
Soluble Mass	Infinite	*(Kg)*

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	5.2		.82	.0							
Dist. from Source (ft)	0	110	220	330	440	550	660	770	880	990	1100

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help | Recalculate This Sheet

Paste Example Dataset

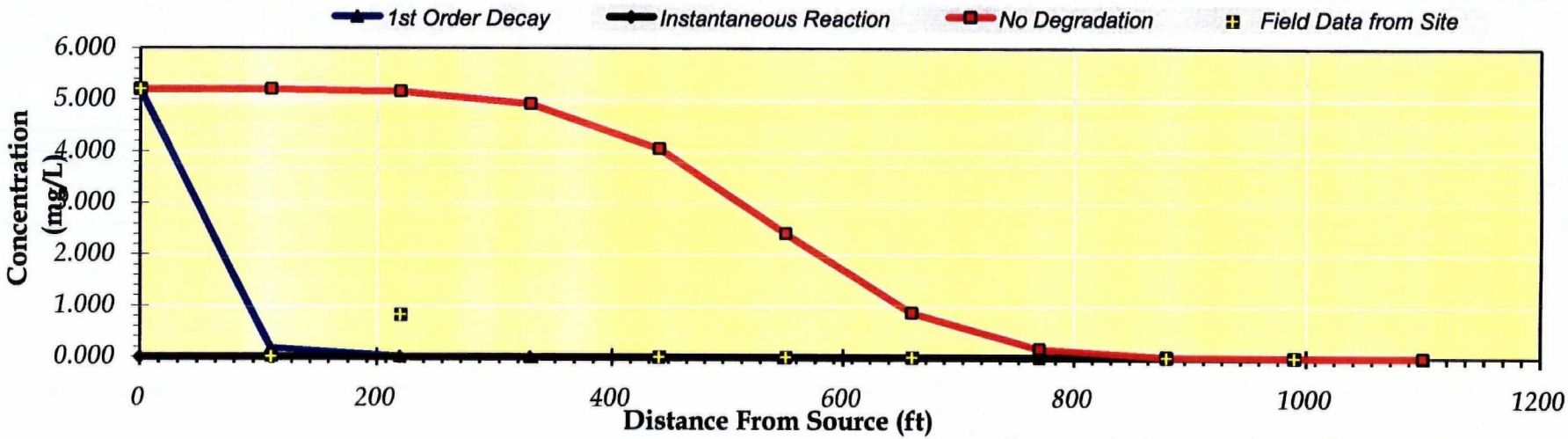
Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 21a
Ethylbenzene Simulation, Parameter Set 1,
Bioscreen Input, Year 2000

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	110	220	330	440	550	660	770	880	990	1100
No Degradation	5.200	5.199	5.162	4.917	4.050	2.408	0.866	0.168	0.016	0.001	0.000
1st Order Decay	5.200	0.178	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	5.2		0.820	0.000							



Replay Animation

Prev Timestep

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 21b
Ethylbenzene Simulation, Parameter Set 1,
Centerline Output, Year 2000

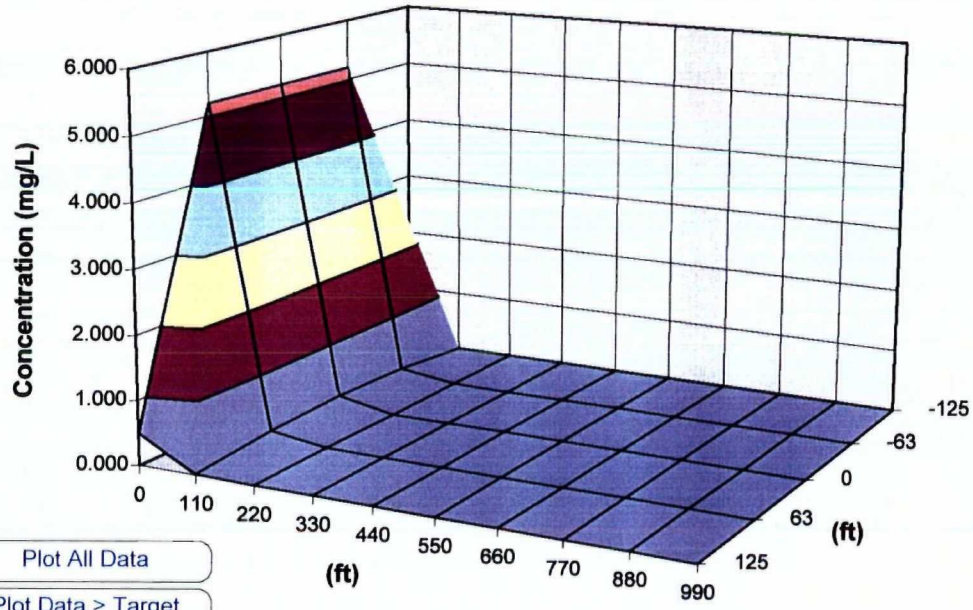
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	110	220	330	440	550	660	770	880	990	1100
125	0.500	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63	5.200	0.139	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0	5.200	0.178	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-63	5.200	0.139	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-125	0.500	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	1.4E+4	5.1E+2	1.7E+1	5.7E-1	2.0E-2	6.7E-4	2.3E-5	7.6E-7	2.3E-8	5.3E-10	7.8E-12

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model

Time: **30 Years** Target Level: **0.005** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	156.2	(Kg)
- Actual Plume Mass	5.0	(Kg)
= Plume Mass Removed by Biodeg	**151.2**	(Kg) (97 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	Infinite	(Kg)
Contam. Mass in Source Now (t=30Years)	Infinite	(Kg)
Current Volume of Groundwater in Plume	5.2	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP

Recalculate

Figure 21c
Ethylbenzene Simulation, Parameter Set 1,
Plume Output, Year 2000

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 9C (2
DEHP_MW6/MW22
Run Name

Data Input Instructions:

115 or 0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	73.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	i	0.003	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	14.0	(ft)
Transverse Dispersivity*	alpha y	1.5	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	320	(ft)

3. ADSORPTION

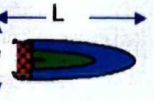
Retardation Factor*	R	9.0	(-)
or		or	
Soil Bulk Density	rho		(kg/l)
Partition Coefficient	Koc		(L/kg)
FractionOrganicCarbon	foc		(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.0E-1	(per yr)
or		or	
Solute Half-Life	t-half		(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	550	(ft)
Modeled Area Width*	250	(ft)
Simulation Time*	30	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

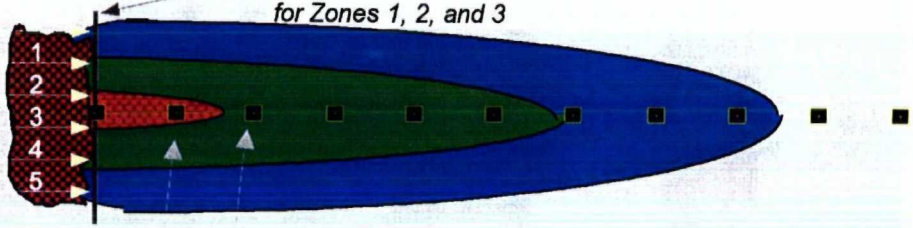
Width* (ft)	Conc. (mg/L)*
50	0.5
50	8
150	80
50	8
50	0.5

Source Halflife (see Help):

1	0.1	(yr)
Inst. React.	1st Order	
Soluble Mass	Infinite	(Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	80.0				.092		.001				
Dist. from Source (ft)	0	55	110	165	220	275	330	385	440	495	550

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help | Recalculate This Sheet

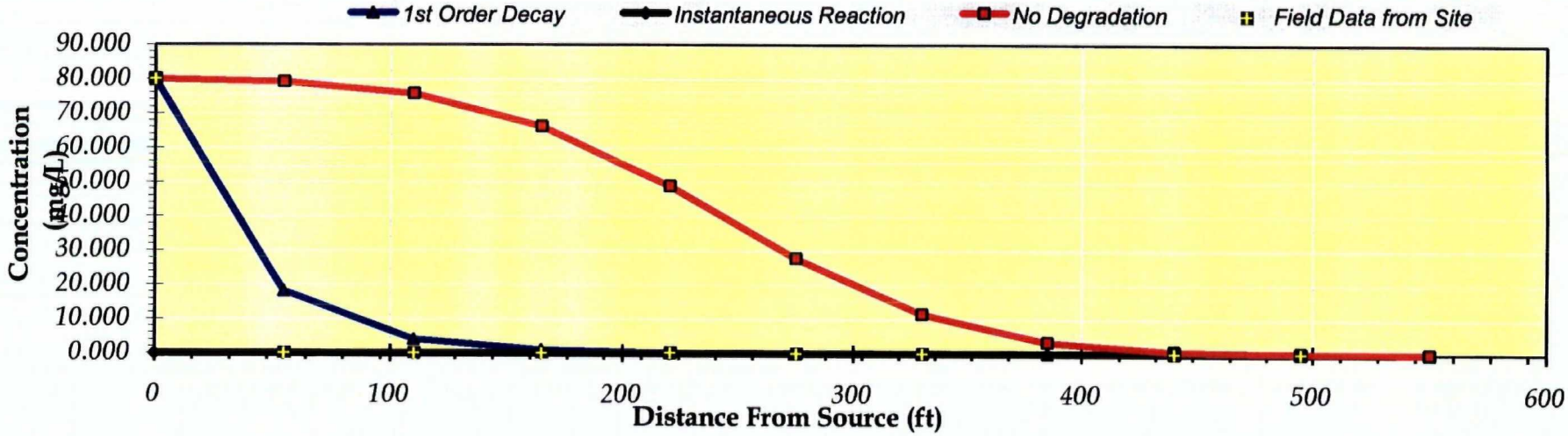
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 22a
DEHP Simulation, Parameter Set 1,
Bioscreen Input, Year 2000

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	55	110	165	220	275	330	385	440	495	550
No Degradation	80.000	79.100	75.748	66.251	48.749	27.822	11.568	3.360	0.663	0.088	0.008
1st Order Decay	80.000	18.245	4.161	0.948	0.214	0.047	0.010	0.002	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	80.0				0.092		0.001				



Calculate Animation

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 22b
DEHP Simulation, Parameter Set 1,
Centerline Output, Year 2000

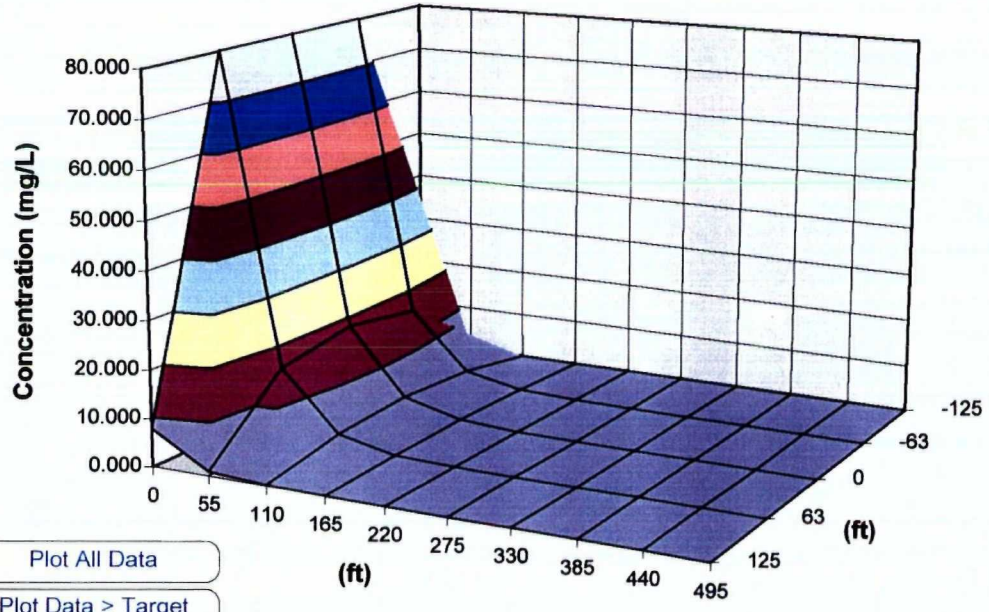
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	55	110	165	220	275	330	385	440	495	550
125	8.000	0.970	0.232	0.061	0.016	0.004	0.001	0.000	0.000	0.000	0.000
63	80.000	15.532	3.241	0.703	0.154	0.033	0.007	0.001	0.000	0.000	0.000
0	80.000	18.245	4.161	0.948	0.214	0.047	0.010	0.002	0.000	0.000	0.000
-63	80.000	15.532	3.241	0.703	0.154	0.033	0.007	0.001	0.000	0.000	0.000
-125	8.000	0.970	0.232	0.061	0.016	0.004	0.001	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	2.2E+5	5.4E+4	1.2E+4	2.6E+3	5.9E+2	1.3E+2	2.7E+1	4.8E+0	6.9E-1	7.3E-2	5.5E-3

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model

Time: **30 Years** Target Level: **0.005** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	2389.2	(Kg)
- Actual Plume Mass	53.2	(Kg)
= Plume Mass Removed by Biodeg	2336.0	(Kg) (98 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	Infinite	(Kg)
Contam. Mass in Source Now (t=30Years)	Infinite	(Kg)
Current Volume of Groundwater in Plume	7.3	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP

Recalculate

Figure 22c
DEHP Simulation, Parameter Set 1,
Plume Output, Year 2000

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 10A (Xylenes, MW6/MW2 — Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	73.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	i	0.003	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	14.0	(ft)
Transverse Dispersivity*	alpha y	1.5	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	320	(ft)

3. ADSORPTION

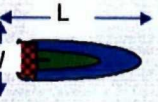
Retardation Factor*	R	3.4	(-)
or		or	
Soil Bulk Density	rho		(kg/l)
Partition Coefficient	Koc		(L/kg)
FractionOrganicCarbon	foc		(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.6E+0	(per yr)
or		or	
Solute Half-Life	t-half		(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	500	(ft)
Modeled Area Width*	250	(ft)
Simulation Time*	30	(yr)



115 or 0.02

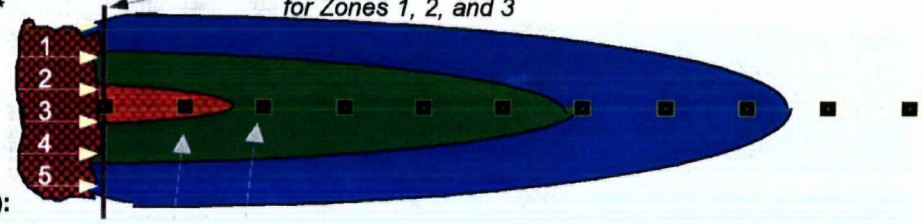
6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
50	0.2
50	2.3
150	23
50	2.3
50	0.2

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Source Halflife (see Help):

( ) (yr)

Inst. React. — 1st Order

Soluble Mass — Infinite (Kg)

In Source NAPL, Soil

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	23.0
50	
100	.22
150	
200	
250	
300	
350	
400	
450	
500	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help — Recalculate This Sheet

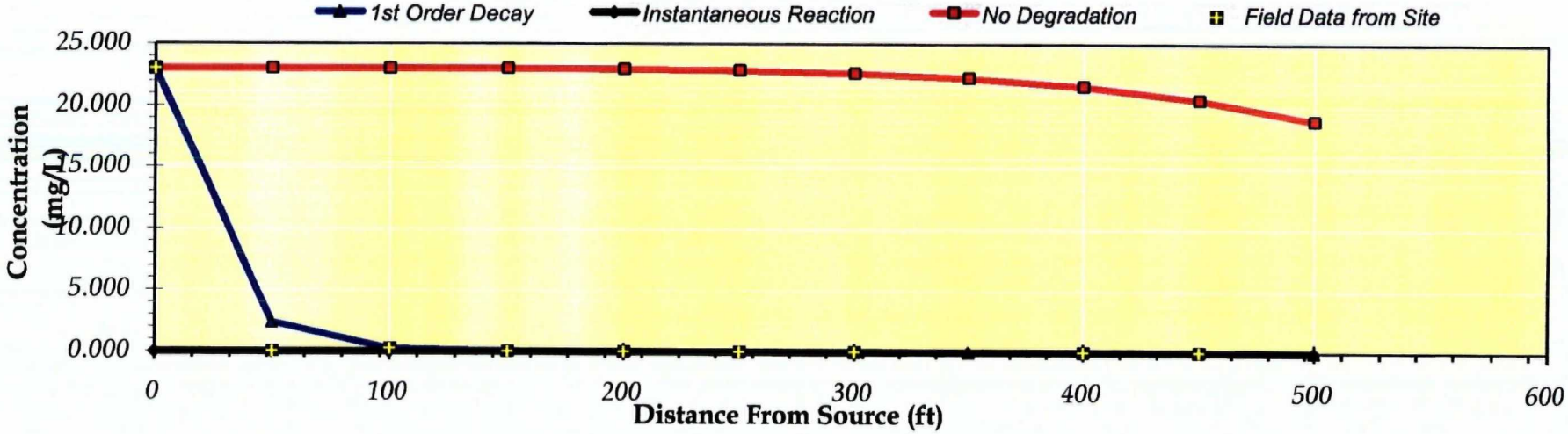
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 23a
Xylenes Simulation, Alternate Flowline,
Bioscreen Input, Year 2000

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	50	100	150	200	250	300	350	400	450	500
No Degradation	23.000	23.000	22.999	22.989	22.944	22.834	22.625	22.251	21.598	20.503	18.803
1st Order Decay	23.000	2.362	0.243	0.025	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	23.0		0.220								



Replay Animation | Prev Timestep

Time: 30 Years

Return to Input | Recalculate This Sheet

Figure 23b
Xylenes Simulation, Alternate Flowline,
Centerline Output, Year 2000

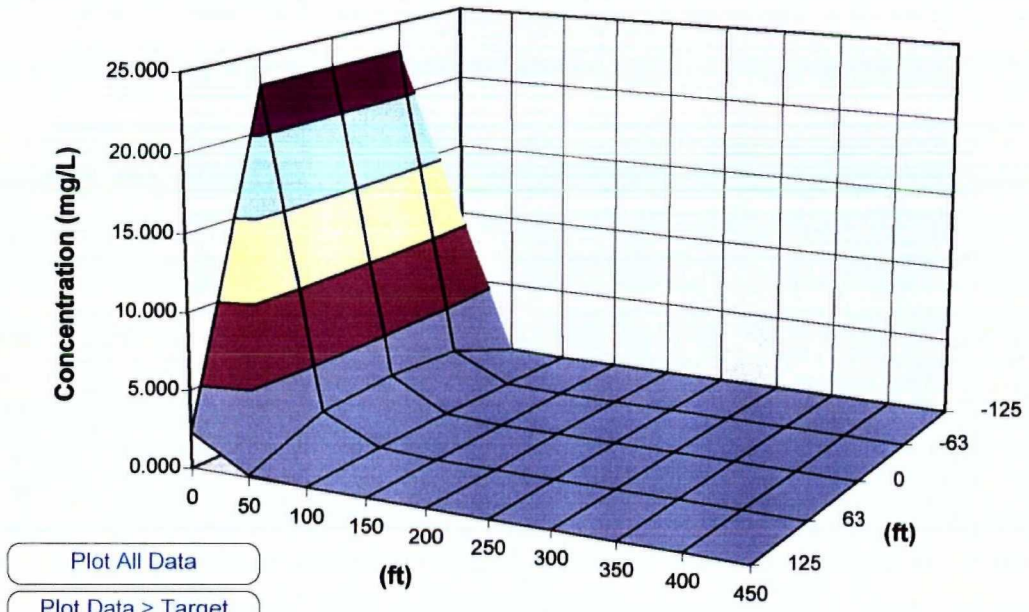
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	50	100	150	200	250	300	350	400	450	500
125	2.300	0.128	0.014	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63	23.000	2.036	0.191	0.019	0.002	0.000	0.000	0.000	0.000	0.000	0.000
0	23.000	2.362	0.243	0.025	0.003	0.000	0.000	0.000	0.000	0.000	0.000
-63	23.000	2.036	0.191	0.019	0.002	0.000	0.000	0.000	0.000	0.000	0.000
-125	2.300	0.128	0.014	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	6.3E+4	7.1E+3	6.9E+2	6.9E+1	7.0E+0	7.2E-1	7.4E-2	7.6E-3	7.7E-4	7.9E-5	8.1E-6

Model to Display:

- *No Degradation Model*
- *1st Order Decay Model*
- *Instantaneous Reaction Model*

Time: **30 Years** Target Level: **0.005** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	687.9	(Kg)
- Actual Plume Mass	14.4	(Kg)
= Plume Mass Removed by Biodeg	673.6	(Kg) (98 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	Infinite	(Kg)
Contam. Mass in Source Now (t=30Years)	Infinite	(Kg)
Current Volume of Groundwater in Plume	3.9	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP

Recalculate

Figure 23c
Xylenes Simulation, Alternate Flowline,
Plume Output, Year 2000

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 10b (Ethylbenzene, MW6/MW2 (2 — *Run Name*

Data Input Instructions:

1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

*Variable** — *Data used directly in model.*

Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	73.0	*(ft/yr)*
or		*or*	
Hydraulic Conductivity	*K*	1.1E-02	*(cm/sec)*
Hydraulic Gradient	*i*	0.003	*(ft/ft)*
Porosity	*n*	0.3	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	14.0	*(ft)*
Transverse Dispersivity*	*alpha y*	1.5	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		*or*	
Estimated Plume Length	*Lp*	320	*(ft)*

3. ADSORPTION

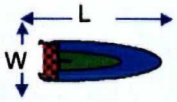
Retardation Factor*	*R*	4.0	*(-)*
or		*or*	
Soil Bulk Density	*rho*		*(kg/l)*
Partition Coefficient	*Koc*		*(L/kg)*
FractionOrganicCarbon	*foc*		*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	2.0E+0	*(per yr)*
or		*or*	
Solute Half-Life	*t-half*		*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	250	*(ft)*
Modeled Area Width*	250	*(ft)*
Simulation Time*	30	*(yr)*



115	*or*
0.02	

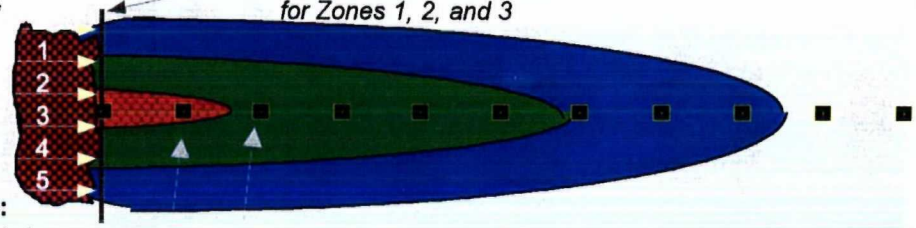
6. SOURCE DATA

Source Thickness in Sat.Zone* 10 *(ft)*

Source Zones:

Width* (ft)	Conc. (mg/L)*
50	0.1
50	0.5
150	5.2
50	0.5
50	0.1

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Source Halflife (see Help):

(yr)

Inst. React. — 1st Order

Soluble Mass: Infinite *(Kg)*

In Source NAPL, Soil

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	5.2
25	
50	
75	
100	.47
125	
150	
175	
200	
225	
250	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

Paste Example Dataset

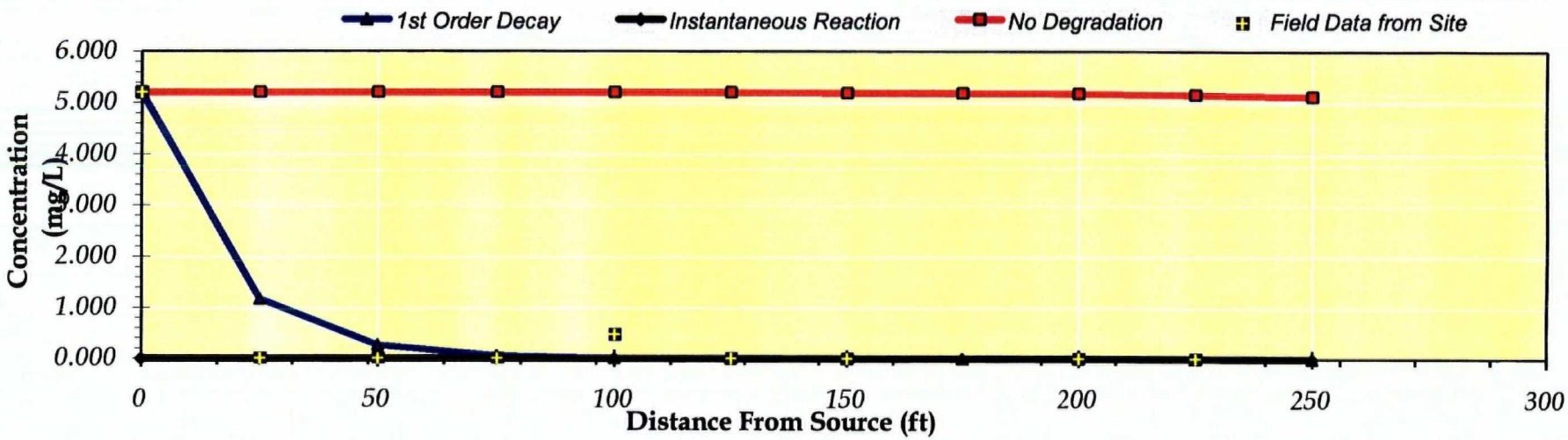
Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 24a
Ethylbenzene Simulation, Alternate Flowline,
Bioscreen Input, Year 2000

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	25	50	75	100	125	150	175	200	225	250
No Degradation	5.200	5.200	5.200	5.200	5.199	5.198	5.195	5.188	5.177	5.158	5.129
1st Order Decay	5.200	1.169	0.263	0.059	0.013	0.003	0.001	0.000	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	5.2				0.047						



Calculate Animation

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 24b
Ethylbenzene Simulation, Alternate Flowline,
Centerline Output, Year 2000

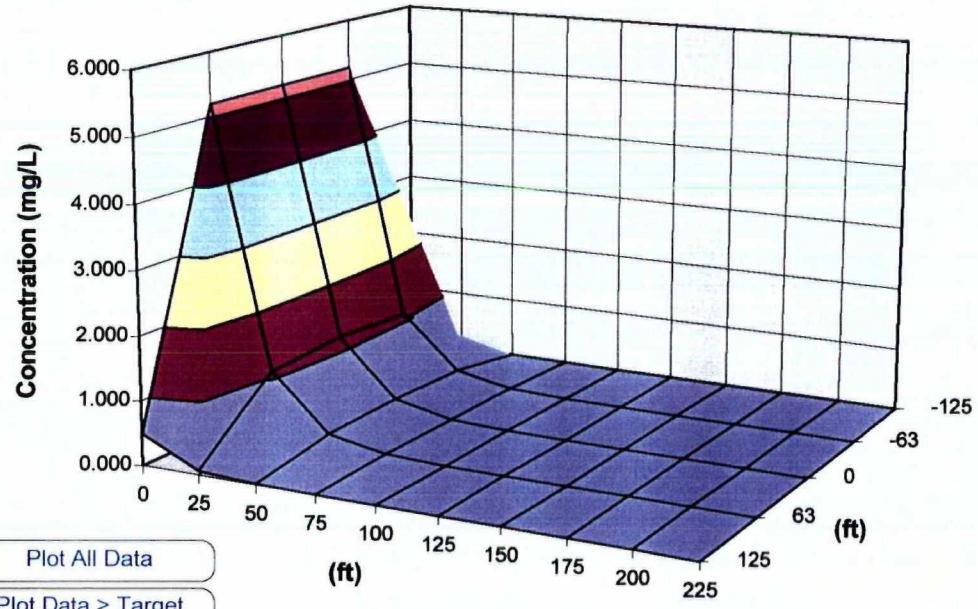
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	25	50	75	100	125	150	175	200	225	250
125	0.500	0.067	0.015	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000
63	5.200	1.090	0.226	0.048	0.010	0.002	0.001	0.000	0.000	0.000	0.000
0	5.200	1.169	0.263	0.059	0.013	0.003	0.001	0.000	0.000	0.000	0.000
-63	5.200	1.090	0.226	0.048	0.010	0.002	0.001	0.000	0.000	0.000	0.000
-125	0.500	0.067	0.015	0.003	0.001	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	1.4E+4	3.7E+3	7.9E+2	1.7E+2	3.8E+1	8.4E+0	1.9E+0	4.2E-1	9.4E-2	2.1E-2	4.7E-3

Model to Display:

- *No Degradation Model*
- *1st Order Decay Model*
- *Instantaneous Reaction Model*

Time: **30 Years** Target Level: **0.005** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	156.2	(Kg)
- Actual Plume Mass	3.4	(Kg)
= Plume Mass Removed by Biodeg	**152.8**	(Kg) (98 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	Infinite	(Kg)
Contam. Mass in Source Now (t=30Years)	Infinite	(Kg)
Current Volume of Groundwater in Plume	2.3	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP

Recalculate

Figure 24c
Ethylbenzene Simulation, Alternate Flowline,
Plume Output, Year 2000

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 10C (DEHP, MW6/MW2 — *Run Name*

Data Input Instructions:

115 ↑ or 0.02

1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

Variable* — *Data used directly in model.*

20 — *Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	73.0	*(ft/yr)*
or		↑ or	
Hydraulic Conductivity	*K*	1.1E-02	*(cm/sec)*
Hydraulic Gradient	*i*	0.003	*(ft/ft)*
Porosity	*n*	0.3	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	14.0	*(ft)*
Transverse Dispersivity*	*alpha y*	1.5	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		↑ or	
Estimated Plume Length	*Lp*	320	*(ft)*

3. ADSORPTION

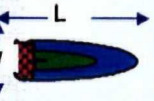
Retardation Factor*	*R*	9.0	*(-)*
or		↑ or	
Soil Bulk Density	*rho*		*(kg/l)*
Partition Coefficient	*Koc*		*(L/kg)*
FractionOrganicCarbon	*foc*		*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	1.7E+0	*(per yr)*
or		↑ or	
Solute Half-Life	*t-half*		*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*		*(mg/L)*
Delta Nitrate*	*NO3*		*(mg/L)*
Observed Ferrous Iron*	*Fe2+*		*(mg/L)*
Delta Sulfate*	*SO4*		*(mg/L)*
Observed Methane*	*CH4*		*(mg/L)*

5. GENERAL

Modeled Area Length*	250	*(ft)*
Modeled Area Width*	250	*(ft)*
Simulation Time*	30	*(yr)*



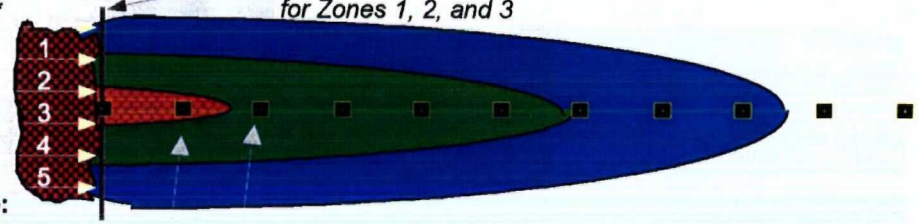
6. SOURCE DATA

Source Thickness in Sat.Zone* 10 *(ft)*

Source Zones:

Width* (ft)	Conc. (mg/L)*
50	0.8
50	8
150	80
50	8
50	0.8

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Source Halflife (see Help):

		(yr)
Inst. React. ↑	↑ 1st Order	
Soluble Mass	Infinite	*(Kg)*

In Source NAPL, Soil

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	80.0
25	
50	
75	
100	.6
125	
150	
175	
200	
225	
250	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help — Recalculate This Sheet

Paste Example Dataset

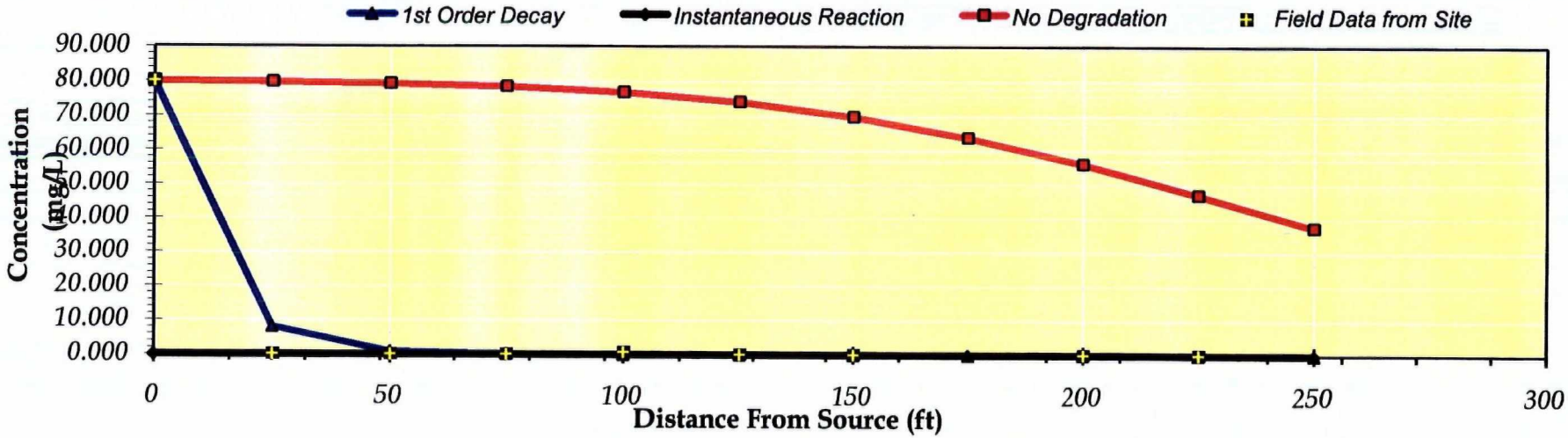
Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 25a
DEHP Simulation, Alternate Flowline,
Bioscreen Input, Year 2000

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	25	50	75	100	125	150	175	200	225	250
No Degradation	80.000	79.673	79.233	78.343	76.700	73.925	69.648	63.629	55.905	46.866	37.217
1st Order Decay	80.000	8.072	0.814	0.082	0.008	0.001	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	80.0				0.600						



Calculate Animation

Time: 30 Years

Return to Input

Recalculate This Sheet

Figure 25b
DEHP Simulation, Alternate Flowline,
Centerline Output, Year 2000

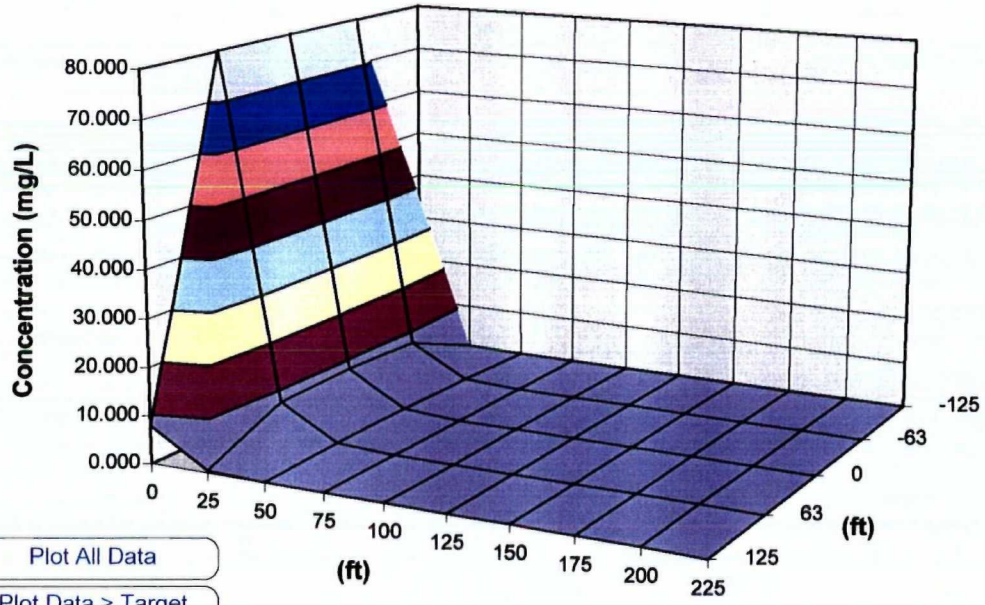
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	25	50	75	100	125	150	175	200	225	250
125	8.000	0.444	0.045	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63	80.000	7.531	0.702	0.067	0.007	0.001	0.000	0.000	0.000	0.000	0.000
0	80.000	8.072	0.814	0.082	0.008	0.001	0.000	0.000	0.000	0.000	0.000
-63	80.000	7.531	0.702	0.067	0.007	0.001	0.000	0.000	0.000	0.000	0.000
-125	8.000	0.444	0.045	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	2.2E+5	2.5E+4	2.4E+3	2.4E+2	2.4E+1	2.4E+0	2.4E-1	2.4E-2	2.4E-3	2.4E-4	2.4E-5

Model to Display:

- *No Degradation Model*
- *1st Order Decay Model*
- *Instantaneous Reaction Model*

Time: **30 Years** Target Level: **0.005** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	2394.8	(Kg)
- Actual Plume Mass	21.4	(Kg)
= Plume Mass Removed by Biodeg	2373.4	(Kg) (99 %)

Change in Electron Acceptor/Byproduct Masses:

Oxygen	*Nitrate*	*Iron II*	*Sulfate*	*Methane*	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	Infinite	(Kg)
Contam. Mass in Source Now (t=30Years)	Infinite	(Kg)
Current Volume of Groundwater in Plume	2.3	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP

Recalculate

Figure 25c
DEHP Simulation, Alternate Flowline,
Plume Output, Year 2000

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

LE Carpenter 5K Xylenes, MW6/MW22 — Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

115 or 0.02

Variable* — Data used directly in model.

20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	73.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.1E-02	(cm/sec)
Hydraulic Gradient	i	0.003	(ft/ft)
Porosity	n	0.3	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	14.0	(ft)
Transverse Dispersivity*	alpha y	1.5	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	320	(ft)

3. ADSORPTION

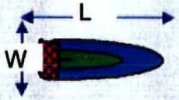
Retardation Factor*	R	3.4	(-)
or		or	
Soil Bulk Density	rho		(kg/l)
Partition Coefficient	Koc		(L/kg)
FractionOrganicCarbon	foc		(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	1.2E+0	(per yr)
or		or	
Solute Half-Life	t-half		(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO		(mg/L)
Delta Nitrate*	NO3		(mg/L)
Observed Ferrous Iron*	Fe2+		(mg/L)
Delta Sulfate*	SO4		(mg/L)
Observed Methane*	CH4		(mg/L)

5. GENERAL

Modeled Area Length*	800	(ft)
Modeled Area Width*	250	(ft)
Simulation Time*	50	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 10 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
50	1
50	12
150	120
50	12
50	1

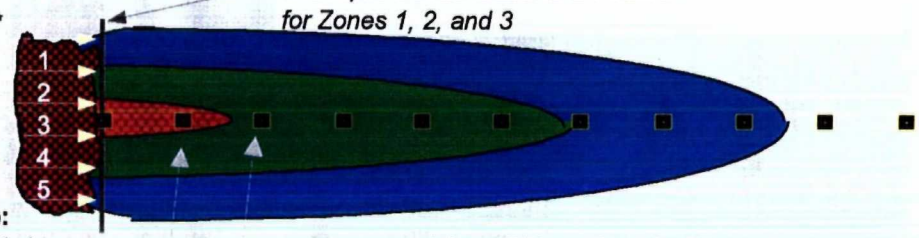
Source Halflife (see Help): (yr)

Inst. React. — 1st Order

Soluble Mass: Infinite (Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Dist. from Source (ft)	Concentration (mg/L)
0	120.0
80	
160	
240	18.0
320	.001
400	
480	
560	
640	
720	
800	

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help — Recalculate This Sheet

Paste Example Dataset

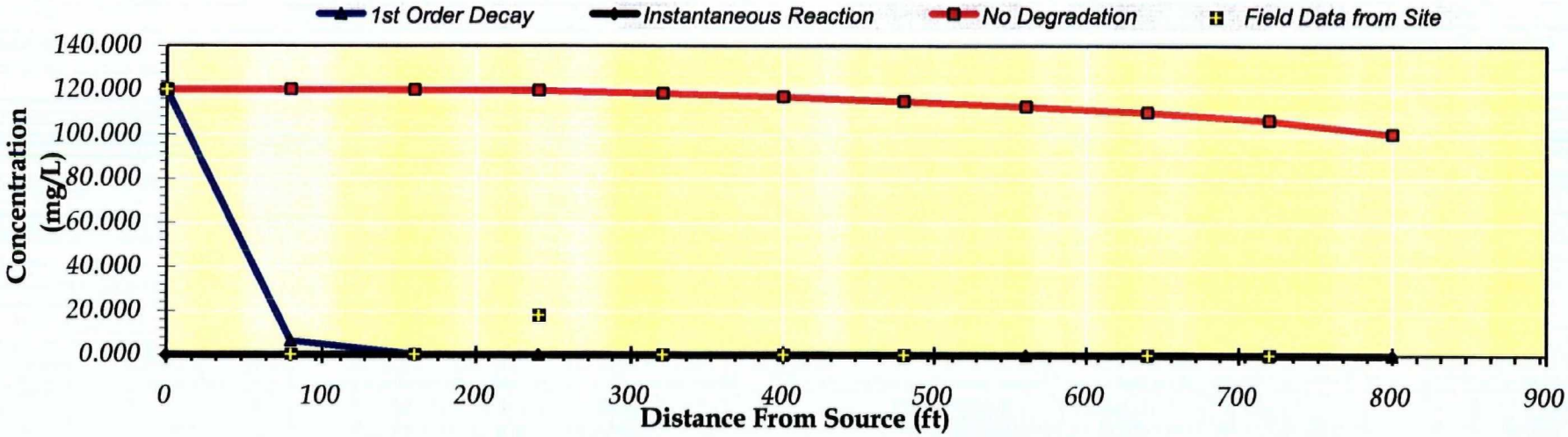
Restore Formulas for Vs, Dispersivities, R, lambda, other

Figure 26a
Xylenes Prediction, Parameter Set 1,
Bioscreen Input

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	80	160	240	320	400	480	560	640	720	800
No Degradation	120.000	120.000	119.933	119.440	118.325	116.709	114.758	112.536	109.875	106.164	100.204
1st Order Decay	120.000	6.286	0.329	0.017	0.001	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!	#VALUE!
Field Data from Site	120.0			18.000	0.001						



Calculate Animation

Time: 50 Years

Return to Input

Recalculate This Sheet

Figure 26b
Xylenes Prediction, Parameter Set 1,
Centerline Output

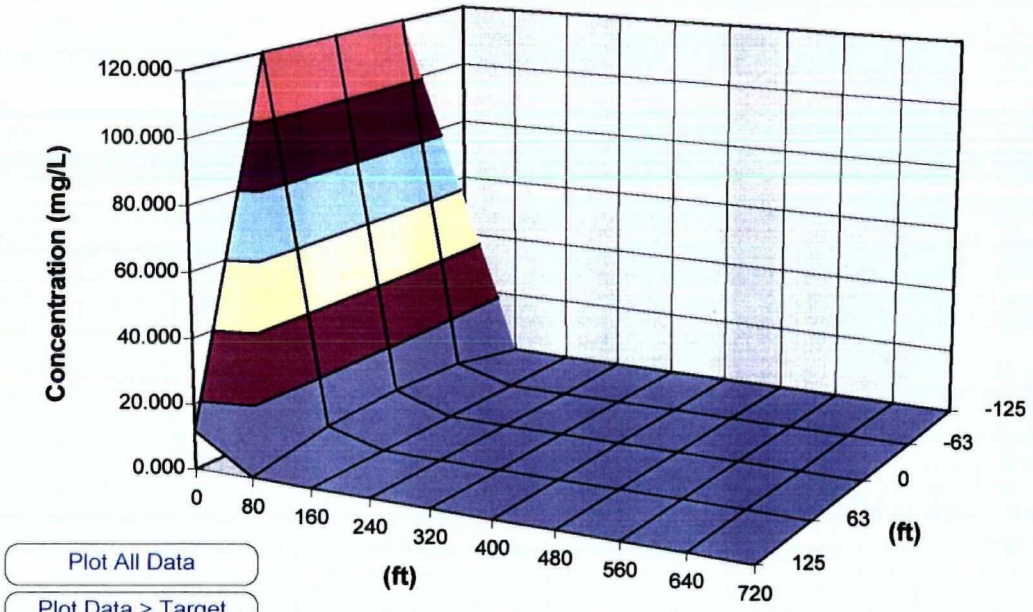
DISSOLVED HYDROCARBON CONCENTRATIONS IN PLUME (mg/L at Z=0)

Transverse Distance (ft) ↓ / Distance from Source (ft) →	0	80	160	240	320	400	480	560	640	720	800
125	12.000	0.344	0.021	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63	120.000	5.099	0.245	0.012	0.001	0.000	0.000	0.000	0.000	0.000	0.000
0	120.000	6.286	0.329	0.017	0.001	0.000	0.000	0.000	0.000	0.000	0.000
-63	120.000	5.099	0.245	0.012	0.001	0.000	0.000	0.000	0.000	0.000	0.000
-125	12.000	0.344	0.021	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
MASS FLUX (mg/day)	3.3E+5	1.8E+4	9.1E+2	4.7E+1	2.5E+0	1.3E-1	6.7E-3	3.5E-4	1.8E-5	9.6E-7	5.0E-8

Model to Display:

- No Degradation Model
- 1st Order Decay Model
- Instantaneous Reaction Model

Time: **50 Years** Target Level: **0.005** mg/L Displayed Model: **1st Order Decay**



Plot All Data

Plot Data > Target

Plume and Source Masses (Order-of-Magnitude Accuracy)

Plume Mass if No Biodegradation	5980.8	(Kg)
- Actual Plume Mass	113.4	(Kg)
= Plume Mass Removed by Biodeg	**5867.3**	(Kg)
	(98 %)	

Change in Electron Acceptor/Byproduct Masses:

Oxygen	Nitrate	Iron II	Sulfate	Methane	
na	na	na	na	na	(Kg)

Contam. Mass in Source (t=0 Years)	Infinite	(Kg)
Contam. Mass in Source Now (t=50Years)	Infinite	(Kg)
Current Volume of Groundwater in Plume	6.2	(ac-ft)
Flowrate of Water Through Source Zone	1.760	(ac-ft/yr)

Mass HELP

Recalculate

Figure 26c
Xylenes Prediction, Parameter Set 1
Plume Output

Appendix A
Laboratory Data Sheets

4th Quarter 1998

Baseline Analysis

ENVIROTECH RESEARCH, INC.

Client ID: **MW15S**
Site: RNA

Lab Sample No: **99777**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Extracted: 12/03/98
Date Analyzed: 12/10/98
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s9421.d

Matrix: WATER
Level: LOW
Sample Volume: 920 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	ND	1.2

ENVIROTECH RESEARCH, INC.

Client ID: **MW15S**
Site: RNA

Lab Sample No: **99777**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/04/98
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4019.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.20
Toluene	ND	0.14
Ethylbenzene	ND	0.14
Xylene (Total)	ND	0.50

ENVIROTECH RESEARCH, INC.

Client ID: MW15S
Site: RNA

Lab Sample No: 99777
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/02/98
GC Column: GS-Q
Instrument ID: VSCREEN3.i
Lab File ID: scrc2090.d

Matrix: WATER
Level: LOW
Purge Volume: 10.0 ml
Final Volume: 0.0 mL
Dilution Factor: 5.0

METHANE, ETHANE, ETHENE
METHOD 3810

Parameter	Analytical Result Units: ug/l	Quantitation Limit Units: ug/l
Methane	80.4	25.0

Client ID: WPA3
Site: RNA

Lab Sample No: 99778
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Extracted: 12/03/98
Date Analyzed: 12/10/98
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s9422.d

Matrix: WATER
Level: LOW
Sample Volume: 980 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	69	1.1

ENVIROTECH RESEARCH, INC.

Client ID: **WPA3**
Site: RNA

Lab Sample No: **99778**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/04/98
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4020.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.20
Toluene	ND	0.14
Ethylbenzene	ND	0.14
Xylene (Total)	ND	0.50

ENVIROTECH RESEARCH, INC.

Client ID: **MW15S**
Site: RNA

Lab Sample No: **99777**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Extracted: 12/03/98
Date Analyzed: 12/10/98
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s9421.d

Matrix: WATER
Level: LOW
Sample Volume: 920 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	ND	1.2

ENVIROTECH RESEARCH, INC.

Client ID: **MW15S**
Site: RNA

Lab Sample No: **99777**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/04/98
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4019.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.20
Toluene	ND	0.14
Ethylbenzene	ND	0.14
Xylene (Total)	ND	0.50

Client ID: MW15S
Site: RNA

Lab Sample No: 99777
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/02/98
GC Column: GS-Q
Instrument ID: VSCREEN3.i
Lab File ID: scrc2090.d

Matrix: WATER
Level: LOW
Purge Volume: 10.0 ml
Final Volume: 0.0 mL
Dilution Factor: 5.0

METHANE, ETHANE, ETHENE
METHOD 3810

Parameter	Analytical Result Units: ug/l	Quantitation Limit Units: ug/l
Methane	80.4	25.0

Client ID: WPA3
Site: RNA

Lab Sample No: 99778
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Extracted: 12/03/98
Date Analyzed: 12/10/98
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s9422.d

Matrix: WATER
Level: LOW
Sample Volume: 980 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	69	1.1

ENVIROTECH RESEARCH, INC.

Client ID: **WPA3**
Site: RNA

Lab Sample No: **99778**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/04/98
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4020.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.20
Toluene	ND	0.14
Ethylbenzene	ND	0.14
Xylene (Total)	ND	0.50

ENVIROTECH RESEARCH, INC.

Client ID: **WPA3**
Site: RNA

Lab Sample No: **99778**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/02/98
GC Column: GS-Q
Instrument ID: VSCREEN3.i
Lab File ID: scrc2080.d

Matrix: WATER
Level: LOW
Purge Volume: 10.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

METHANE, ETHANE, ETHENE
METHOD 3810

Parameter	Analytical Result Units: ug/l	Quantitation Limit Units: ug/l
Methane	ND	5.00

Client ID: **MW17S**
Site: RNA

Lab Sample No: **99779**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Extracted: 12/03/98
Date Analyzed: 12/10/98
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s9423.d

Matrix: WATER
Level: LOW
Sample Volume: 1000 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	6.0	1.1

ENVIROTECH RESEARCH, INC.

Client ID: **MW17S**
Site: RNA

Lab Sample No: **99779**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/04/98
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4021.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.20
Toluene	ND	0.14
Ethylbenzene	ND	0.14
Xylene (Total)	ND	0.50

ENVIROTECH RESEARCH, INC.

Client ID: MW17S
Site: RNA

Lab Sample No: 99779
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/02/98
GC Column: GS-Q
Instrument ID: VSCREEN3.i
Lab File ID: scrc2081.d

Matrix: WATER
Level: LOW
Purge Volume: 10.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

METHANE, ETHANE, ETHENE
METHOD 3810

Parameter	Analytical Result Units: ug/l	Quantitation Limit Units: ug/l
Methane	ND	5.00

Client ID: WPC4
Site: RNA

Lab Sample No: 99780
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Extracted: 12/03/98
Date Analyzed: 12/12/98
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s9463.d

Matrix: WATER
Level: LOW
Sample Volume: 1000 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 5.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	540	5.4

Client ID: **WPC4**
Site: RNA

Lab Sample No: **99780**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/04/98
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4009.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 2.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.40
Toluene	0.87	0.28
Ethylbenzene	26.1	0.28
Xylene (Total)	82.4	1.0

Client ID: **WPC4**
Site: RNA

Lab Sample No: **99780**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/02/98
GC Column: GS-Q
Instrument ID: VSCREEN3.i
Lab File ID: scrc2091.d

Matrix: WATER
Level: LOW
Purge Volume: 10.0 ml
Final Volume: 0.0 mL
Dilution Factor: 25.0

METHANE, ETHANE, ETHENE
METHOD 3810

Parameter	Analytical Result Units: ug/l	Quantitation Limit Units: ug/l
Methane	996	125

Client ID: WPB10
Site: RNA

Lab Sample No: 99781
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Extracted: 12/03/98
Date Analyzed: 12/12/98
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s9464.d

Matrix: WATER
Level: LOW
Sample Volume: 970 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 25.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	2600	28

Client ID: WPB10
Site: RNA

Lab Sample No: 99781
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/04/98
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4004.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 50.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	10.0
Toluene	ND	7.0
Ethylbenzene	478	7.0
Xylene (Total)	2400	25.0

Client ID: WPB10
Site: RNA

Lab Sample No: 99781
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/02/98
GC Column: GS-Q
Instrument ID: VSCREEN3.i
Lab File ID: scrc2092.d

Matrix: WATER
Level: LOW
Purge Volume: 10.0 ml
Final Volume: 0.0 mL
Dilution Factor: 200.0

METHANE, ETHANE, ETHENE
METHOD 3810

Parameter	Analytical Result Units: ug/l	Quantitation Limit Units: ug/l
Methane	6740	1000

Client ID: MW2R
Site: RNA

Lab Sample No: 99782
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Extracted: 12/03/98
Date Analyzed: 12/12/98
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s9465.d

Matrix: WATER
Level: LOW
Sample Volume: 990 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 50.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	9800	54

Client ID: **MW2R**
Site: RNA

Lab Sample No: **99782**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/04/98
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4010.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 100.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	20.0
Toluene	ND	14.0
Ethylbenzene	679	14.0
Xylene (Total)	3230	50.0

ENVIROTECH RESEARCH, INC.

Client ID: **MW2R**
Site: RNA

Lab Sample No: **99782**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/02/98
GC Column: GS-Q
Instrument ID: VSCREEN3.i
Lab File ID: scrc2093.d

Matrix: WATER
Level: LOW
Purge Volume: 10.0 ml
Final Volume: 0.0 mL
Dilution Factor: 200.0

METHANE, ETHANE, ETHENE
METHOD 3810

Parameter	Analytical Result Units: ug/l	Quantitation Limit Units: ug/l
Methane	6690	1000

Client ID: WPB6
Site: RNA

Lab Sample No: 99783
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Extracted: 12/03/98
Date Analyzed: 12/12/98
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s9466.d

Matrix: WATER
Level: LOW
Sample Volume: 960 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 250.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	42000	280

Client ID: **WPB6**
Site: RNA

Lab Sample No: **99783**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/04/98
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4011.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 50.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	10.0
Toluene	ND	7.0
Ethylbenzene	276	7.0
Xylene (Total)	1310	25.0

Client ID: WPB6
Site: RNA

Lab Sample No: 99783
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/02/98
GC Column: GS-Q
Instrument ID: VSCREEN3.i
Lab File ID: scrc2094.d

Matrix: WATER
Level: LOW
Purge Volume: 10.0 ml
Final Volume: 0.0 mL
Dilution Factor: 250.0

METHANE, ETHANE, ETHENE
METHOD 3810

Parameter	Analytical Result Units: ug/l	Quantitation Limit Units: ug/l
Methane	9910	1250

Client ID: **Field_Blank**
Site: RNA

Lab Sample No: **99784**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Extracted: 12/03/98
Date Analyzed: 12/11/98
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s9428.d

Matrix: WATER
Level: LOW
Sample Volume: 960 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	5.7	1.1

Client ID: **Field_Blank**
Site: RNA

Lab Sample No: **99784**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/02/98
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid3993.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.20
Toluene	ND	0.14
Ethylbenzene	ND	0.14
Xylene (Total)	ND	0.50

ENVIROTECH RESEARCH, INC.

Client ID: **Field_Blank**
Site: RNA

Lab Sample No: **99784**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/02/98
GC Column: GS-Q
Instrument ID: VSCREEN3.i
Lab File ID: scrc2086.d

Matrix: WATER
Level: LOW
Purge Volume: 10.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

METHANE, ETHANE, ETHENE
METHOD 3810

Parameter	Analytical Result Units: ug/l	Quantitation Limit Units: ug/l
Methane	ND	5.00

Site: RNA

Lab Job No: J534

Date Sampled: 12/1/98
Date Received: 12/1/98
Matrix: WATER

Date Analyzed: 12/8/98
QA Batch: 1190

FERROUS IRON

Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
99777	MW15S	1.0	0.56
99778	WPA3	1.0	ND
99779	MW17S	1.0	ND
99780	WPC4	5.0	7.6
99781	WPB10	25	32.4
99782	MW2R	25	35.4
99783	WPB6	50	59.8
99784	Field_Blank	1.0	ND

Quantitation Limit for ferrous iron is 1.0 mg/l for an undiluted sample.

Site: RNA

Lab Job No: J534

Date Sampled: 12/1/98
Date Received: 12/1/98
Matrix: WATER

Date Analyzed: 12/2/98
QA Batch: 0153

NITRATE

Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
99777	MW15S	1.0	0.14
99778	WPA3	1.0	0.57
99779	MW17S	1.0	0.15
99780	WPC4	1.0	ND
99781	WPB10	1.0	ND
99782	MW2R	1.0	ND
99783	WPB6	1.0	ND
99784	Field_Blank	1.0	ND

Quantitation Limit for Nitrate is 0.1 mg/l for an undiluted sample.

Site: RNA

Lab Job No: J534

Date Sampled: 12/1/98
Date Received: 12/1/98
Matrix: WATER

Date Analyzed: 12/8/98
QA Batch: 1223

SULFATE

Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
99777	MW15S	1.0	5.3
99778	WPA3	1.0	13.5
99779	MW17S	1.0	15.1
99780	WPC4	1.0	ND
99781	WPB10	1.0	7.6
99782	MW2R	1.0	ND
99783	WPB6	1.0	ND
99784	Field_Blank	1.0	ND

Quantitation Limit for Sulfate is 5.0 mg/l for an undiluted sample.

Site: RNA

Lab Job No: J534

Date Sampled: 12/1/98
Date Received: 12/1/98
Matrix: WATER

Date Analyzed: 12/8/98
QA Batch: 1147

TOTAL PHOSPHORUS

Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
99777	MW15S	1.0	ND
99778	WPA3	1.0	0.1
99779	MW17S	1.0	ND
99780	WPC4	1.0	0.23
99781	WPB10	1.0	0.39
99782	MW2R	1.0	0.3
99783	WPB6	10	0.86
99784	Field_Blank	1.0	ND

Quantitation Limit for Total Phosphorus is 1.5 mg/l for an undiluted sample.

Client ID: **Trip_Blank**
Site: RNA

Lab Sample No: **99785**
Lab Job No: J534

Date Sampled: 12/01/98
Date Received: 12/01/98
Date Analyzed: 12/02/98
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid3994.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.20
Toluene	ND	0.14
Ethylbenzene	ND	0.14
Xylene (Total)	ND	0.50

1st Quarter 1999

Client ID: **Trip_Blank**
Site: Le Carpenter

Lab Sample No: **108735**
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Analyzed: 01/29/99
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4834.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.20
Toluene	ND	0.14
Ethylbenzene	ND	0.14
Xylene (Total)	ND	0.50

Client ID: **WP-A3**
Site: Le Carpenter

Lab Sample No: **108736**
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Extracted: 01/26/99
Date Analyzed: 01/27/99
GC Column: DB-5
Instrument ID: BNAMS3.i
Lab File ID: t2317.d

Matrix: WATER
Level: LOW
Sample Volume: 970 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	5.4	4.2

Client ID: **WP-A3**
Site: Le Carpenter

Lab Sample No: **108736**
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Analyzed: 01/29/99
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4835.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.20
Toluene	ND	0.14
Ethylbenzene	ND	0.14
Xylene (Total)	ND	0.50

Client ID: MW-17s
Site: Le Carpenter

Lab Sample No: 108737
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Extracted: 01/26/99
Date Analyzed: 01/27/99
GC Column: DB-5
Instrument ID: BNAMS3.i
Lab File ID: t2318.d

Matrix: WATER
Level: LOW
Sample Volume: 1000 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	6.0	4.1

Client ID: **MW-17s**
Site: Le Carpenter

Lab Sample No: **108737**
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Analyzed: 01/29/99
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4836.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.20
Toluene	ND	0.14
Ethylbenzene	ND	0.14
Xylene (Total)	ND	0.50

Client ID: WP-C4
Site: Le Carpenter

Lab Sample No: 108738
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Extracted: 01/26/99
Date Analyzed: 01/27/99
GC Column: DB-5
Instrument ID: BNAMS3.i
Lab File ID: t2319.d

Matrix: WATER
Level: LOW
Sample Volume: 900 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	25	4.5

Client ID: **WP-C4**
Site: Le Carpenter

Lab Sample No: **108738**
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Analyzed: 01/29/99
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4837.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.20
Toluene	ND	0.14
Ethylbenzene	2.2	0.14
Xylene (Total)	9.0	0.50

Client ID: **WP-B6**
Site: Le Carpenter

Lab Sample No: **108739**
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Extracted: 01/26/99
Date Analyzed: 01/27/99
GC Column: DB-5
Instrument ID: BNAMS3.i
Lab File ID: t2321.d

Matrix: WATER
Level: LOW
Sample Volume: 1000 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 5.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	510	20

STL Envirotech
A division of Severn Trent Laboratories, Inc.

Client ID: **WP-B6**
Site: Le Carpenter

Lab Sample No: **108739**
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Analyzed: 01/29/99
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4829.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 100.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	20
Toluene	ND	14
Ethylbenzene	680	14
Xylene (Total)	2700	50

Client ID: **MW-2R**
Site: Le Carpenter

Lab Sample No: **108740**
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Extracted: 01/26/99
Date Analyzed: 01/28/99
GC Column: DB-5
Instrument ID: BNAMS3.i
Lab File ID: t2335.d

Matrix: WATER
Level: LOW
Sample Volume: 1000 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 500.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	52000	2000

Client ID: **MW-2R**
Site: Le Carpenter

Lab Sample No: **108740**
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Analyzed: 01/30/99
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4855.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 250.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	50
Toluene	ND	35
Ethylbenzene	1100	35
Xylene (Total)	5700	120

Client ID: WP-B10
Site: Le Carpenter

Lab Sample No: 108741
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Extracted: 01/26/99
Date Analyzed: 01/28/99
GC Column: DB-5
Instrument ID: BNAMS3.i
Lab File ID: t2323.d

Matrix: WATER
Level: LOW
Sample Volume: 920 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 5.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	420	22

Client ID: **WP-B10**
Site: Le Carpenter

Lab Sample No: **108741**
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Analyzed: 01/30/99
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4856.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 100.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	20
Toluene	ND	14
Ethylbenzene	1000	14
Xylene (Total)	5000	50

Client ID: **Field_Blank**
Site: Le Carpenter

Lab Sample No: **108742**
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Extracted: 01/26/99
Date Analyzed: 01/27/99
GC Column: DB-5
Instrument ID: BNAMS3.i
Lab File ID: t2320.d

Matrix: WATER
Level: LOW
Sample Volume: 960 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	ND	4.2

Client ID: **Field_Blank**
Site: Le Carpenter

Lab Sample No: **108742**
Lab Job No: K971

Date Sampled: 01/22/99
Date Received: 01/22/99
Date Analyzed: 01/29/99
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid4838.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.20
Toluene	ND	0.14
Ethylbenzene	ND	0.14
Xylene (Total)	ND	0.50

Site: Le Carpenter

Lab Job No: K971

Date Sampled: 1/22/99
Date Received: 1/22/99
Matrix: WATER

Date Analyzed: 1/25/99
QA Batch: 1198

FERROUS IRON

Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
108736	WP-A3	1.0	ND
108737	MW-17s	1.0	ND
108738	WP-C4	1.0	0.25
108739	WP-B6	25	37.9
108740	MW-2R	25	19.0
108741	WP-B10	25	22.1
108742	Field_Blank	1.0	ND

Quantitation Limit for ferrous iron is 1.0 mg/l for an undiluted sample.

Site: Le Carpenter

Lab Job No: K971

Date Sampled: 1/22/99
Date Received: 1/22/99
Matrix: WATER

Date Analyzed: 1/23/99
QA Batch: 0164

NITRATE

Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
108736	WP-A3	1.0	1.0
108737	MW-17s	1.0	0.17
108738	WP-C4	1.0	0.52
108739	WP-B6	1.0	ND
108740	MW-2R	1.0	ND
108741	WP-B10	1.0	ND
108742	Field_Blank	1.0	ND

Quantitation Limit for Nitrate is 0.1 mg/l for an undiluted sample.

2nd Quarter 1999

STL Envirotech

Client ID: **WP-A3**
Site: LE Carpenter

Lab Sample No: **125615**
Lab Job No: N593

Date Sampled: 04/16/99
Date Received: 04/16/99
Date Extracted: 04/20/99
Date Analyzed: 04/22/99
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s2060.d

Matrix: WATER
Level: LOW
Sample Volume: 970 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	ND	4.2

Client ID: **WP-A3**
Site: LE Carpenter

Lab Sample No: **125615**
Lab Job No: N593

Date Sampled: 04/16/99
Date Received: 04/16/99
Date Analyzed: 04/22/99
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid6049.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.31
Toluene	ND	0.34
Ethylbenzene	ND	0.38
Xylene (Total)	ND	0.40

Client ID: **WP-C4**
Site: LE Carpenter

Lab Sample No: **125616**
Lab Job No: N593

Date Sampled: 04/16/99
Date Received: 04/16/99
Date Extracted: 04/20/99
Date Analyzed: 04/22/99
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s2061.d

Matrix: WATER
Level: LOW
Sample Volume: 980 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	200 B	4.2

Client ID: WP-C4
Site: LE Carpenter

Lab Sample No: 125616
Lab Job No: N593

Date Sampled: 04/16/99
Date Received: 04/16/99
Date Analyzed: 04/22/99
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid6050.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.31
Toluene	0.70	0.34
Ethylbenzene	0.48	0.38
Xylene (Total)	1.4	0.40

Client ID: **WP-B10**
Site: LE Carpenter

Lab Sample No: **125617**
Lab Job No: N593

Date Sampled: 04/16/99
Date Received: 04/16/99
Date Extracted: 04/20/99
Date Analyzed: 04/22/99
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s2063.d

Matrix: WATER
Level: LOW
Sample Volume: 960 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	230 B	4.2

Client ID: **WP-B10**
Site: LE Carpenter

Lab Sample No: **125617**
Lab Job No: N593

Date Sampled: 04/16/99
Date Received: 04/16/99
Date Analyzed: 04/23/99
GC Column: DB624
Instrument ID: VOAGC2.i
Lab File ID: hpid0511.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 25.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	7.8
Toluene	ND	8.5
Ethylbenzene	200	9.5
Xylene (Total)	930	10

Envirotech

Client ID: **MW-2R**
Site: LE Carpenter

Lab Sample No: **125618**
Lab Job No: N593

Date Sampled: 04/16/99
Date Received: 04/16/99
Date Extracted: 04/20/99
Date Analyzed: 04/22/99
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s2075.d

Matrix: WATER
Level: LOW
Sample Volume: 980 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 100.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	13000 B	420

STL Envirotech

Client ID: **MW-2R**
Site: LE Carpenter

Lab Sample No: **125618**
Lab Job No: N593

Date Sampled: 04/16/99
Date Received: 04/16/99
Date Analyzed: 04/23/99
GC Column: DB624
Instrument ID: VOAGC2.i
Lab File ID: hpid0512.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 25.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	7.8
Toluene	ND	8.5
Ethylbenzene	200	9.5
Xylene (Total)	820	10

STL Envirotech

Client ID: **WP-B6**
Site: LE Carpenter

Lab Sample No: **125619**
Lab Job No: N593

Date Sampled: 04/16/99
Date Received: 04/16/99
Date Extracted: 04/20/99
Date Analyzed: 04/23/99
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s2076.d

Matrix: WATER
Level: LOW
Sample Volume: 1000 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 10.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	2000 B	41

Client ID: **WP-B6**
Site: LE Carpenter

Lab Sample No: **125619**
Lab Job No: N593

Date Sampled: 04/16/99
Date Received: 04/16/99
Date Analyzed: 04/23/99
GC Column: DB624
Instrument ID: VOAGC2.i
Lab File ID: hpid0513.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 50.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	16
Toluene	ND	17
Ethylbenzene	1000	19
Xylene (Total)	3200	20

Client ID: **Trip_Blank**
Site: LE Carpenter

Lab Sample No: **125620**
Lab Job No: N593

Date Sampled: 04/16/99
Date Received: 04/16/99
Date Analyzed: 04/22/99
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid6051.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.31
Toluene	ND	0.34
Ethylbenzene	ND	0.38
Xylene (Total)	ND	0.40

Client ID: **Field_Blank**
Site: LE Carpenter

Lab Sample No: **125621**
Lab Job No: N593

Date Sampled: 04/16/99
Date Received: 04/16/99
Date Extracted: 04/20/99
Date Analyzed: 04/22/99
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s2065.d

Matrix: WATER
Level: LOW
Sample Volume: 900 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	ND	4.5

Client ID: **Field_Blank**
Site: LE Carpenter

Lab Sample No: **125621**
Lab Job No: N593

Date Sampled: 04/16/99
Date Received: 04/16/99
Date Analyzed: 04/22/99
GC Column: DB624
Instrument ID: VOAGC3.i
Lab File ID: ipid6052.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.31
Toluene	ND	0.34
Ethylbenzene	ND	0.38
Xylene (Total)	ND	0.40

Site: LE Carpenter

Lab Job No: N593

Date Sampled: 4/16/99
Date Received: 4/16/99
Matrix: WATER

Date Analyzed: 4/23/99
QA Batch: 0187

NITRATE

STL-Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
125615	WP-A3	1.0	0.6
125616	WP-C4	1.0	ND
125617	WP-B10	1.0	ND
125618	MW-2R	1.0	ND
125619	WP-B6	1.0	ND
125621	Field_Blank	1.0	ND

Quantitation Limit for Nitrate is 0.1 mg/l for an undiluted sample.

Site: LE Carpenter

Lab Job No: N593

Date Sampled: 4/16/99
Date Received: 4/16/99
Matrix: WATER

Date Analyzed: 4/22/99
QA Batch: 1231

FERROUS IRON

STL-Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
125615	WP-A3	1.0	ND
125616	WP-C4	1.0	0.79
125617	WP-B10	50	20.8
125618	MW-2R	50	37.2
125619	WP-B6	50	36.7
125621	Field_Blank	1.0	ND

Quantitation Limit for ferrous iron is 0.1 mg/l for an undiluted sample.

3rd Quarter 1999

Client ID: WP-A3
Site: LE Carpenter-RNA

Lab Sample No: 145804
Lab Job No: R742

Date Sampled: 07/23/99
Date Received: 07/23/99
Date Extracted: 07/27/99
Date Analyzed: 07/31/99
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s3990.d

Matrix: WATER
Level: LOW
Sample Volume: 960 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	ND	4.2

Client ID: WP-A3
Site: LE Carpenter-RNA

Lab Sample No: 145804
Lab Job No: R742

Date Sampled: 07/23/99
Date Received: 07/23/99
Date Analyzed: 07/30/99
GC Column: DB624
Instrument ID: VOAGC2.i
Lab File ID: hpid1621.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.31
Toluene	ND	0.34
Ethylbenzene	ND	0.38
Xylene (Total)	ND	0.40

Client ID: WP-B10
Site: LE Carpenter-RNA

Lab Sample No: 145805
Lab Job No: R742

Date Sampled: 07/23/99
Date Received: 07/23/99
Date Extracted: 07/27/99
Date Analyzed: 08/02/99
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s4013.d

Matrix: WATER
Level: LOW
Sample Volume: 980 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 25.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	2200	100

Client ID: **WP-B10**
Site: LE Carpenter-RNA

Lab Sample No: **145805**
Lab Job No: R742

Date Sampled: 07/23/99
Date Received: 07/23/99
Date Analyzed: 07/31/99
GC Column: DB624
Instrument ID: VOAGC2.i
Lab File ID: hpid1628.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 100.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	31
Toluene	57	34
Ethylbenzene	200	38
Xylene (Total)	1400	40

Client ID: **MW2R**
Site: LE Carpenter-RNA

Lab Sample No: **145806**
Lab Job No: R742

Date Sampled: 07/23/99
Date Received: 07/23/99
Date Extracted: 07/27/99
Date Analyzed: 08/02/99
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s4014.d

Matrix: WATER
Level: LOW
Sample Volume: 970 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 100.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	16000	420

Client ID: MW2R
Site: LE Carpenter-RNA

Lab Sample No: 145806
Lab Job No: R742

Date Sampled: 07/23/99
Date Received: 07/23/99
Date Analyzed: 08/02/99
GC Column: DB624
Instrument ID: VOAGC2.i
Lab File ID: hpid1647.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 50.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	16
Toluene	ND	17
Ethylbenzene	380	19
Xylene (Total)	1700	20

Client ID: WP-B6
Site: LE Carpenter-RNA

Lab Sample No: 145807
Lab Job No: R742

Date Sampled: 07/23/99
Date Received: 07/23/99
Date Extracted: 07/27/99
Date Analyzed: 08/02/99
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s4015.d

Matrix: WATER
Level: LOW
Sample Volume: 990 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 500.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	39000	2100

Client ID: WP-B6
Site: LE Carpenter-RNA

Lab Sample No: 145807
Lab Job No: R742

Date Sampled: 07/23/99
Date Received: 07/23/99
Date Analyzed: 08/02/99
GC Column: DB624
Instrument ID: VOAGC2.i
Lab File ID: hpid1648.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 100.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	31
Toluene	ND	34
Ethylbenzene	170	38
Xylene (Total)	1600	40

Site: LE Carpenter-RNA

Lab Job No: R742

Date Sampled: 7/23/99
Date Received: 7/23/99
Matrix: WATER

Date Analyzed: 7/26/99
QA Batch: 1261

FERROUS IRON

STL-Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
145804	WP-A3	1.0	ND
145805	WP-B10	50	42.7
145806	MW2R	50	44.7
145807	WP-B6	50	60.2

Quantitation Limit for Ferrous Iron is 0.1 mg/l for an undiluted sample.

X-Method 3500-Fe (Standard Methods for the Examination of Water and Wastewater, 18th Edition) specifies that ferrous iron be determined "at sampling site because of the possibility of change in the ferrous-ferric ratio with time in acid solutions" p3-67.

Site: LE Carpenter-RNA

Lab Job No: R742

Date Sampled: 7/23/99
Date Received: 7/23/99
Matrix: WATER

Date Analyzed: 7/26/99
QA Batch: 0232

NITRATE

STL-Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
145804	WP-A3	1.0	0.38
145805	WP-B10	1.0	ND
145806	MW2R	1.0	ND
145807	WP-B6	1.0	ND

Quantitation Limit for Nitrate is 0.1 mg/l for an undiluted sample.

Client ID: **WP-C1**
Site: L.E. Carpenter

Lab Sample No: **146533**
Lab Job No: R874

Date Sampled: 07/28/99
Date Received: 07/28/99
Date Extracted: 07/31/99
Date Analyzed: 08/05/99
GC Column: DB-5
Instrument ID: BNAMS2.i
Lab File ID: s4083.d

Matrix: WATER
Level: LOW
Sample Volume: 780 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	16	5.2

Client ID: **WP-C1**
Site: L.E. Carpenter

Lab Sample No: **146533**
Lab Job No: R874

Date Sampled: 07/28/99
Date Received: 07/28/99
Date Analyzed: 08/03/99
GC Column: DB624
Instrument ID: VOAGC2.i
Lab File ID: hpid1673.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.31
Toluene	ND	0.34
Ethylbenzene	ND	0.38
Xylene (Total)	ND	0.40

Site: L.E. Carpenter

Lab Job No: R874

Date Sampled: 7/28/99
Date Received: 7/28/99
Matrix: WATER

Date Analyzed: 8/10/99
QA Batch: 1264

FERROUS IRON

STL-Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
146533	WP-C1	25	13.8

Quantitation Limit for Ferrous Iron is 0.1 mg/l for an undiluted sample.

X-Method 3500-Fe (Standard Methods for the Examination of Water and Wastewater, 18th Edition) specifies that ferrous iron be determined "at sampling site because of the possibility of change in the ferrous-ferric ratio with time in acid solutions" p3-67.

Site: L.E. Carpenter

Lab Job No: R874

Date Sampled: 7/28/99
Date Received: 7/28/99
Matrix: WATER

Date Analyzed: 7/28/99
QA Batch: 0232

NITRATE

STL-Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
146533	WP-C1	1.0	ND

Quantitation Limit for Nitrate is 0.1 mg/l for an undiluted sample.

Client ID: **MW15S**
Site: L.E. Carpenter-RNA

Lab Sample No: **145569**
Lab Job No: R707

Date Sampled: 07/22/99
Date Received: 07/22/99
Date Extracted: 07/24/99
Date Analyzed: 08/03/99
GC Column: DB-5
Instrument ID: BNAMS3.i
Lab File ID: t5798.d

Matrix: WATER
Level: LOW
Sample Volume: 980 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	ND	4.2

Client ID: **MW17S**
Site: L.E. Carpenter-RNA

Lab Sample No: **145570**
Lab Job No: R707

Date Sampled: 07/22/99
Date Received: 07/22/99
Date Extracted: 07/24/99
Date Analyzed: 08/03/99
GC Column: DB-5
Instrument ID: BNAMS3.i
Lab File ID: t5799.d

Matrix: WATER
Level: LOW
Sample Volume: 970 ml
Extract Final Volume: 2.0 ml
Dilution Factor: 1.0

SEMI-VOLATILE ORGANICS - GC/MS
METHOD 625

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
bis(2-Ethylhexyl)phthalate	ND	4.2

Client ID: **MW17S**
Site: L.E. Carpenter-RNA

Lab Sample No: **145570**
Lab Job No: R707

Date Sampled: 07/22/99
Date Received: 07/22/99
Date Analyzed: 07/30/99
GC Column: DB624
Instrument ID: VOAGC2.i
Lab File ID: hpid1620.d

Matrix: WATER
Level: LOW
Purge Volume: 5.0 ml
Final Volume: 0.0 mL
Dilution Factor: 1.0

VOLATILE ORGANICS - GC/PID
METHOD 602

Parameter	Analytical Result Units: ug/l	Method Detection Limit Units: ug/l
Benzene	ND	0.31
Toluene	ND	0.34
Ethylbenzene	ND	0.38
Xylene (Total)	ND	0.40

Site: L.E. Carpenter-RNA

Lab Job No: R707

Date Sampled: 7/22/99
Date Received: 7/22/99
Matrix: WATER

Date Analyzed: 7/26/99
QA Batch: 1259

FERROUS IRON

STL-Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
145569	MW15S	1.0	1.5
145570	MW17S	1.0	ND

Quantitation Limit for Ferrous Iron is 0.1 mg/l for an undiluted sample.

X-Method 3500-Fe (Standard Methods for the Examination of Water and Wastewater, 18th Edition) specifies that ferrous iron be determined "at sampling site because of the possibility of change in the ferrous-ferric ratio with time in acid solutions" p3-67.

Site: L.E. Carpenter-RNA

Lab Job No: R707

Date Sampled: 7/22/99
Date Received: 7/22/99
Matrix: WATER

Date Analyzed: 7/23/99
QA Batch: 0234

NITRATE

STL-Envirotech Sample #	Client ID	Dilution Factor	Analytical Result Units: mg/l
145569	MW15S	1.0	0.18
145570	MW17S	1.0	ND

Quantitation Limit for Nitrate is 0.1 mg/l for an undiluted sample.